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CONTENTS:

	PAGE
What is Electricity?	659
The Application of Lead Dust in Accumulators	660
The New System of Alternating Current and Transformer Distribution (*illustrated*) (*concluded*)	661
Arc Lighting.—XIII. (*illustrated*)	662
The Impedance of Mutually Inductive Circuits Containing Capacities (*illustrated*)	664
The Physiological Effects of High Frequency Electric Currents	666
The "See-sawing" of Arc Lamps (*illustrated*)	667
Experiments on Brown's Asynchronous Motors (*illustrated*)	667
Electrolytic Christmas Box	668
The Pyke and Harris Continuous Current Dynamos (*illustrated*)	668
Alternate Current Electrolysis (*illustrated*)	669
Correspondence:—Fuel Economy	671
Hedgehog Transformers and Condensers	671
Count Mattei's Remedies	671
Mr. Robert Hammond's Explanation	672
Woodhouse & Rawson United	672
Notes	673
Contracts Open and Closed	676
Business Notices	676
City Notes:—	
Swan United Electric Light Company	678
Elmore's French Copper Company	679
Traffic Receipts	679
Share List of Electrical Companies	680
The Bristol Recording Voltmeter (*illustrated*)	681
Block Signalling.—Board of Trade Returns	681
Underground Wires for Electric Lighting and Power Distribution	682
New Patents	685
Abstracts of Published Specifications	686

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WHAT IS ELECTRICITY?

OUR contemporary, the *Electrical World* of New York, in a recent issue, comments on the fact that it seems inexplicable to the public at large that the mystery about electricity is not dispelled. Electricity is now putting itself so much in evidence for the production of light and power, that the question is likely to become of still more universal interest. It is questionable, however, whether the theory of electricity is so far behind the theories of light, heat, chemical action, and gravitation. Maxwell's electro-magnetic theory of light—the grandest generalisation of the century—has gone far to make the theories of light and heat merely particular cases of the theory of electricity. The most recent theories of chemical action seek to explain it by electrical actions. The theory of gravitation may be said to be where Newton left it, and presents, in the present state of our knowledge, an insoluble problem.

No explanation of electricity will satisfy us except it be mechanical. It must be possible to construct, or at least represent the construction of a model whose actions and inter-actions will correspond to those in the electric and magnetic fields. Many more or less successful attempts have already been made to design such models, and they are of great service in enabling one to grasp the nature of electrical actions. The simpler phenomena are clearly illustrated, but when applied to more abstruse actions the tendency of these models is to become complicated and unmechanical.

Though we know so much more about the nature of electricity than we did 50 years ago, the large number of different theories at present in the field compels us to admit that we are still very far from the complete explanation. Lodge appears to believe electricity to be of the nature of a material fluid whose locomotion, rotation, or vibration produces the electric current, magnetism, or light. Poynting, on the other hand, does not believe in the substantiality of electricity; he believes, however, that the electric energy does not flow along the wire, but takes short cuts to it, through the dielectric.

The ether plays an important part in most of the modern theories of electricity, and up till recently it has been considered to have the properties of an elastic solid. It has now, however, been found necessary to abandon this position, and this, no doubt, will entail a considerable revision of the views of many of our *savants*. Mr. Glazebrook, in his Presidential address at the British Association at Nottingham, stated that "the elastic solid theory of the ether had failed," and suggested as a substitute Lord Kelvin's labile or froth ether. The great objection to the elastic solid ether is that it cannot transmit transverse vibrations without at the same time transmitting longitudinal vibrations, and these latter are inconsistent with known phenomena of light. The labile ether, whose elasticity is due to surface tension, transmits

transverse but not longitudinal waves. From this ether Maxwell's equations of the electro-magnetic field can be deduced, and it supplies explanations on many points where the elastic solid theory failed. The stresses in the ether, however, are not those given by Maxwell's theory. Several other theories of the ether have been proposed, such as Lord Kelvin's gyrostatic molecule and vortex sponge theories, and these give better explanations in many points than the labile ether. All this only serves to show how far we are from finality in our knowledge of the ultimate nature of electricity.

THE APPLICATION OF LEAD DUST IN ACCUMULATORS.

IN the *Electrotechnische Zeitschrift* an account is given by C. Liebenow of some interesting experiments to determine the value of lead dust as a filling material for the negative plates of accumulators. As is well known, the active surface of the negative plates of accumulators must be very large, to obtain a large storage capacity. This is effected, according to the Faure principle, by coating the negative plates with red lead or litharge, and reducing it to finely divided lead by the first charging current. In recent times many attempts have been made to obviate the first charging, by substituting finely divided metallic lead for the red lead or litharge hitherto used. The writer has carried out a series of parallel experiments with plates coated partly with red lead and litharge, and partly with the finest lead powder.

The first material tested was lead dust formed by a jet of steam. The particles of lead thus obtained looked oval under the microscope, but greatly exceeded in size those obtained from the red lead and litharge on the ordinary accumulator plates. With this material accumulator plates were filled in the ordinary way, some with the pure lead dust, and others with a mixture of the dust and 10 per cent. of red lead and litharge. Similar plates filled with the ordinary paste of red lead and litharge were used as a standard for comparison. The storage capacities obtained from the mean of 20 discharges were as follows :—

Plates filled with—

Pure lead dust	43·3 per cent.
Lead dust with 10 per cent. red lead ...	46·7 „
Lead dust with 10 per cent. litharge ...	60 „
The ordinary paste	100 „

The inferior efficiency of the lead dust evidently was due to the greater size of its particles ; and it was found impossible to obtain smaller particles from the melted lead. A finer powder was afterwards obtained, which was said to be produced by grinding solid lead. Under the microscope this had the appearance of having been broken up, and was very similar in its outer form to ground red lead and litharge. The grains were, however, about double the size of the particles of the finest red lead and litharge. The storage capacity of this material was found to be about 55 per cent. of that of the ordinary paste. Finally, a specimen of lead dust was obtained, which equalled in fineness the red lead and litharge. But even this gave a storage capacity of 81 to 85 per cent. only.

The explanation of these results is evidently to be sought for in the peculiar constitution of the particles of red lead and litharge. These are evidently made up of an exceedingly great number of molecules of oxygen and lead, from which the oxygen atoms are driven out by the electric current when the plates are being first formed. Every particle of lead formed by the current is therefore in itself a porous body, while the particles of the mechanically produced lead dust are not further disintegrated. It may be possible by mechanical means to produce still finer lead dust, but the same means will equally, if not more so, reduce the red lead and litharge. The red lead and litharge will thus always maintain its advantage in storage capacity over the lead dust. Moreover, the price of the finest orange red lead is only about 30 per cent. above that of lead in ingots, and the lead dust costs about six times as much as the latter.

It has been urged that a greater quantity of lead can be got on the plates by the use of lead dust, but the storage capacity does not depend so much on the quantity of lead as on its porosity and consequent great active surface. Thus, notwithstanding the small advantage of dispensing with the forming current, the use of lead dust in accumulators appears to be out of the question.

From Bad to Worse.

WE understand that a contract has been signed between Her Majesty's Government and the Eastern Extension Telegraph Company for the making and laying of a new cable to be laid between Hong Kong and Singapore, touching at Labuan *en route*, and having a total length of about 2,000 miles. This alternative cable has been probably, to some extent, rendered necessary by the state of the existing cable, which has broken down on three several occasions since February last year. Concerning the new project, the *Times* remarks, with reason, that the existing cable, which passes through the French territory of Saigon, will, in case of war, be quite as useless as a cable across the Pacific would be which landed in the French islands of New Caledonia. It might also be pointed out that the same good reason applies to the whole of the Eastern Extension system which is connected with lines which pass through Egyptian territory. Referring to the proposed scheme, it may be recollected that in 1885, '86, '88, the question of a cable from Hong Kong to Singapore, not touching on foreign territory, was considered by the Government, but without any definite decision being taken. In April, 1889, the manager in China of the Australasia and China Telegraph Company says, in a letter to the Colonial Secretary in Hong Kong: "I would point out that the existing cables are amply sufficient to carry a considerable increase of the present traffic, and as the additional traffic due to the establishment of the proposed new cable would be entirely insignificant in proportion to the large outlay, my directors instruct me to state that the extension could only be carried out in consideration of the undertaking being subsidised by the Governments interested. From this it seems that the Eastern Extension Telegraph Company cannot rely on the traffic to justify the laying of such a cable; and hence it would appear that they are about to work under some subsidy or guarantee from Government, the terms of which have not yet been made public. It is no doubt desirable that, as far as possible, communication with British colonies should not pass through the territory of a foreign power. But this idea should be carried out with a certain amount of foresight and discretion. We have already pointed out in this journal the futility, during war time, of such a cable as the above-mentioned ; and it is difficult to see, when the outlay is taken into consideration, what useful purpose it may serve at any other time. In the Labuan-Singapore section (a distance of about 700 miles), the cable will be in water not exceeding 40 fathoms in depth, and for nearly 200 miles from Hong Kong the depth is less than 100 fathoms. It will be easily realised that, if necessary, a cable laid in such shallow water would form a convenient reserve, of which an enemy in the China seas might avail himself, by picking up and relaying it in any place where it might be useful to him. As we pointed out on a former occasion in referring to this cable, "It would be much wiser and much more economical to keep such a cable in a tank *in England* ; the traffic might not be so great, but there would be the negative advantage that in war time the cable could not be used against us by our adversaries."

THE NEW SYSTEM OF ALTERNATING CURRENT AND TRANSFORMER DISTRIBUTION.

By RANKIN KENNEDY.

No. VII.

CONVERTERS.

THE converter is an apparatus for turning the alternating currents into continuous currents. Unlike the "reproducers" described in our last article, they do not "transform;" they merely commutate a current, so that they are usually employed in conjunction with transformers, by which the primary current is adjusted to the required pressures.

Fig. 20 is a converter of the author's design for two-phase

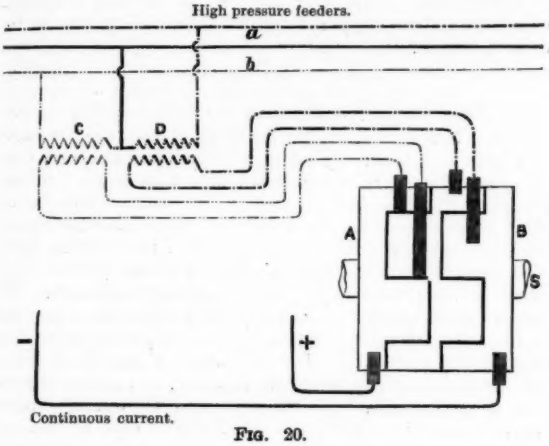
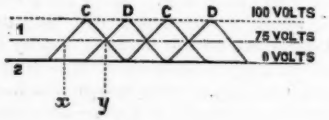


FIG. 20.

currents; in this form there are two commutators, one for each current. These commutators may be driven by one synchronising motor; the motor being a two-phase one is self-starting. S is the shaft of the synchronising motor, A is the commutator for the one current, B the commutator for the other current, C and D are the two transformers for reducing the pressure from the mains, *a*, *b*. If the connections are followed, it will be seen that the two secondary currents are put in series by the commutators and rectified, and thus we get the currents represented by curves 14 and 15 in fig. 8, article IV., page 580.



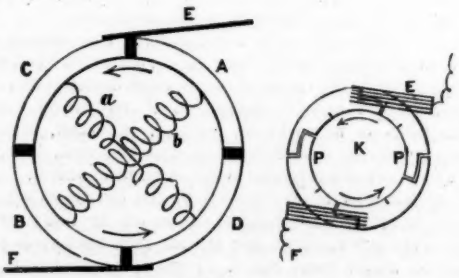


FIG. 21.

For high pressures and small currents this converter works beautifully.

For low pressures and large currents, the currents must be rectified and coupled in parallel by the commutator, and only a portion of the current taken off, or rather the current should be drawn during a portion of the time of one wave of pressure. In fig. 21 the curves, C, D, C, D, represent the two currents rectified. It will be seen that they cut each other on line 1, at that point their pressures are equal. Now, if we make a commutator as in fig. 21, of four parts, A, B, C, D, *b* is a coil representing the secondary of one transformer, and *a* is a coil representing the secondary of the other transformer. The arrangement is precisely similar to an open coil dynamo and commutator; on revolving the commutator each current can feed into the brushes, E, F, during one-fourth of a revolution; that is, the brushes are in contact with the coil during the time the pressure wave is at a crest from X to Y, as seen in our wave diagram, that is for only a quarter of the time during which the wave lasts. The induced wave lasts during the time of one-half of a revolution, rising to and falling from 100 volts. Now, if we arrange our commutator brushes to make contact when the pressure has risen to 75 volts, and maintain the contact until it has again fallen to 75 volts, we shall find that contact must last just about the quarter revolution with a four-part commutator.

Of course, at 75 volts' pressure, there would be sparking on breaking the contact, unless precautionary devices were applied in the commutators. There are several methods, however, to overcome this difficulty; one is to prolong the contact on the commutator plates by lengthening them in the opposite direction from the rotation, as shown in fig. K in fig. 21, where E, F, are the brushes. By this means the rising pressure of the one transformer or current overpowers, and to some extent reverses the current before contact is broken.

This is the device adopted to prevent sparking, in the well-known Brush arc lighting machine, and it serves its purpose very well. It is remarkable that, with the exception of Kapp, it has never occurred to any of the many writers on arc lighting dynamos, that the proper way to clearly explain the Brush machine is to consider it as a multiphase generator. It is a fact that this old machine is actually a multiphase generator, in which commutators are employed to rectify the currents, and put them in series. Explained in this way, what to most students is a difficult machine to understand, becomes at once clear. A Brush arc dynamo makes an excellent two or three-phase generator or motor, and can also be used as a converter from alternating to continuous current, and so can the Thomson-Houston arc dynamo, which is also a three-phase generator with a rectifying commutator; Hutin and Leblanc's reproducer, described in our last article, No. 6, can also be used simply as a converter.

Appolony has applied his system also to single phase currents, as shown in fig. 22, and as this method could be com-

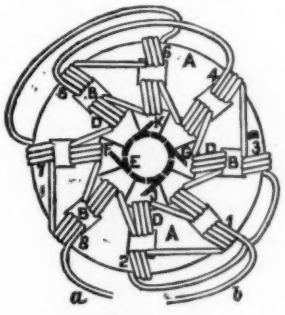


FIG. 22.

bined with advantage with the Hutin and Leblanc series coupling, and employing a separate ring for each current, we may examine this plan here. The outer coils are the primaries, and the arc coupled so as to produce in the secondaries currents in the one half exactly opposed to the currents in the other half of them.

The brushes arrive at these points where the opposed currents meet at the moment the two pressures are a maximum. The current produced may have a higher or lower pressure than the primary current, and it is not nearly constant. It is in reality an intermittent current; but by using two of these apparatus, and working them with currents in quadrature, and coupling the brushes across in series, a very steady current would be produced.

The conversion of alternating currents into continuous currents is a very important subject, and one in which a great deal of work is being done. From the short notices of the

various proposals hitherto published, to which I have herein referred, it will be seen that there are many ways of attacking the problem, and some very pretty inventions have been made to accomplish the conversion in a very simple manner.

In this series of articles, a universal system of electrical distribution has been merely outlined, many details have been passed over or only lightly touched, but the leading features have been, I hope, laid out clearly enough.

This is not a mere proposal to assist the present systems out of present difficulties; the proposition is this: "In a city or district, electricity is required for all purposes; one consumer wants continuous current, another alternating, and another multiphase currents. Some consumers may want all three of them; how are they all to be supplied by the simplest machinery from one centre, using storage for all circuits?" The system sketched is a solution of this problem, without any necessity for any radical alterations in existing dynamos as commonly used.

It is said that one current is quite sufficient for all purposes; that may be so in some places at present, but one current, whether continuous or alternating, can never supply everything, nor effect every operation in distributing electrical energy.

Already we have this exemplified in the proposal to light Edinburgh by a mixed system. Here it is proposed to use two plants, a continuous and an alternating plant in one station. There cannot be the least doubt that if such a mixed system is good, the new system, which would supply both currents from one plant, would be infinitely better. The alternating current would be drawn from the continuous current dynamos.

Again, in alternating plants, we find rectifiers being adopted to derive continuous currents from the alternating, thus proving again my contention that one supply is not sufficient. Again, when the problem of the distribution of electrical energy from Niagara Falls was discussed, it was at once seen how feeble the continuous or alternating systems were when applied alone to really large work, and a two-phase system was adopted solely on account of its easy transformation and conversion into either current.

The present systems of distribution are being adopted on too large a scale at the expense of the public. The idea is, that they can in future adopt improvements and get the benefits of future developments, to improve their system and reduce the present price per unit; in that they are doomed to disappointment. At present there is nothing to complain of, but sooner or later, when the gilt has worn off, the exact limitations of the systems now being adopted will become apparent, and then some improved system, such as is here sketched, will no doubt be adopted.

I may, in another series of articles, describe the motors of various kinds which can be used on a universal system, and also refer to further developments of the reproducers and converters.

Storage batteries are in a very unsatisfactory stage of development, as can be discovered only when one comes to look for them as reservoirs for large stores. At the ideal station the generators would, like gas retorts, run all the time, all supplies being drawn from a store only. Till this can be accomplished, the art of electrical distribution is far from being complete. Direct supply from the generators is a barbaric stage through which the art is at present passing.

(*Concluded.*)

ARC LIGHTING.

By E. TREMLETT CARTER.

(*Continued from page* 551).

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XIII.

(In order to arrive at once at that part of our subject which deals directly with arc lamps, and not to extend the series with matter of lesser importance, we shall omit the sections on dynamos and alternators for parallel running of arc lamps, for the present.)

IV.—The Design of Arc Lamps.

14. *General Object in View.*—In this chapter we shall deal only with lamps for general lighting purposes, reserving the subject of special lamps for a later treatment. Given a pair of suitable carbons, the general object in view in designing an arc lamp may be summarised under the following heads:—

(*a*) Rapid and silent starting. Many lamps take several seconds and even minutes before they give a steady light, during which they emit a hissing noise; this vice is known as pumping. (*b*) Steady running. This will partly be ensured by careful attention to the design of the dynamo and mains; but the lamp must be constructed to give a steady light even though there be some unsteadiness in the current or voltage. Unsteadiness may arise from improper supply of power, from exposure of the arc to wind, from dirtiness of the mechanism, or from its being tilted out of proper position, or from imperfections in the carbons. (*c*) Proper distribution of light. (*d*) Suitable duration of the light. This is either effected by means of long carbons, or by having several pairs of carbons to be used in succession. Lamps with one pair of carbons are known as single-carbon lamps; those with two pairs, as double-carbon lamps; those with more than two pairs are usually called magazine lamps. (*e*) High efficiency of the working parts. Some energy is necessarily consumed in the controlling mechanism; but this can be made small by suitable design. It is not always necessary to attend to this point, as will be seen later. (*f*) Proper isolation of the lamp from the circuit when it is exhausted or out of order. This is necessary in order that the working of other lamps on the same circuit may not be interfered with. Mechanism for this is called a cut-out. (*g*) Simplicity of the working parts. There can be no doubt that the general tendency of arc lamp design at the present day is towards greater simplicity. The modern lamp, though it has many more functions to perform, in starting, controlling, &c., is a much simpler machine than it was a few years ago. The advantage of simplicity lies in the reduced tendency to get out of order, and in the lessened cost of attendance. (*h*) Compactness of working parts. This is chiefly to minimise the shadows cast by the mechanism case. Throughout the lamp the avoidance of shadows must be kept in view as an important element of design. (*i*) Lightness of lamp mechanism and frame. (*j*) Suitability of general shape. (*k*) Cheapness in first cost, and cheapness and facility in repairs.

It is not necessary to mention the more obvious points of design, such as the proper choice of materials, &c., but it may be pointed out in addition to the foregoing that many makers add several other important qualifications to their lamps for general purposes. These are principally:—(*l*) That the point of light is maintained fixed, relatively to the lamp frame, during the whole run of the carbons. The device for effecting this is called a focussing gear. Perfect focussing is only possible with single carbon lamps. Many lamp users object to double-carbon lamps on account of the fact that when the change-over takes place all the shadows cast by the light are shifted sideways in proportion to the lateral distance between the two pairs of carbons; while lamps which are non-focussing cause a continual steady shifting—sometimes an enlargement—of the shadows. (*m*) Compensation for the varying weight of carbon during running. (*n*) Adaptability of the lamp to several kinds of circuits.

15. *Classification.*—It was formerly the custom to enter into an elaborate classification of arc lamps, in treatises on the subject: and the basis of such classification was the very unsatisfactory one of distinction of regulating mechanism. This basis is unworkable, because, in detail, almost every lamp possesses a different mechanism, and, in principle, almost every lamp possesses the same mechanism. Certainly the system was more rational in the old times when almost every imaginable mechanical device was applied to arc lamps; but at the present time the author feels that such a mode of division would break down. Indeed, it would seem that the most natural method of classifying lamps would be to consider them in relation to the various kinds of circuits to which they are adapted, in which case we arrive at the following classes:—

Class 1.—Continuous current lamps for series work.
Class 2.—Alternate current lamps for series work.
Class 3.—Continuous current lamps for parallel work.
Class 4.—Alternate current lamps for parallel work.

Many lamps will, with slight modifications, work on any one of these systems; and most lamps which will work with one

kind of current on a series circuit can be made to work with the same kind of current in parallel. Lamps designed for one kind of current cannot, however, without modification be worked with the other kind of current, as will be made clear in the sequel.

16. *Continuous Current Lamps for Series Working.*—At this stage we shall study a typical lamp, taking for the purpose the lamp made by the Brush Electrical Engineering Company Fig. 40 shows the internal connections of the lamp mechanism and carbons. A pair of hollow solenoids, A and B, are wound with a few turns of insulated copper wire, of sufficient section to carry the main current without heating; and these coils are placed in series with the carbons, as shown. There are two pairs of carbons, R and S, but the main current passes firstly through S, and when this pair is consumed it passes through R. From the main coils, which are connected to the positive terminal, the current passes to the *top* carbons, and from the lower carbons it is conducted to the negative terminal. By this arrangement the crater is formed at the end of the upper carbon and the light is mostly thrown downwards. The core, C, of the solenoids acts upon the clutch which either raises or lowers the carbon holders; and the action is such that when the current passes through these main coils the core lifts the top carbon holders and strikes the arc. The dotted line in the diagram represents a high

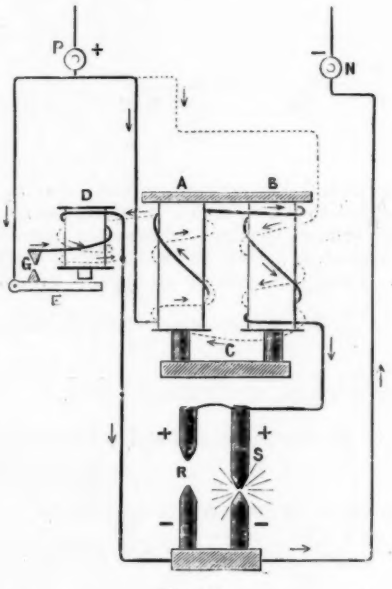


FIG. 40.

resistance shunt circuit, composed of a large number of turns of fine wire wound around the two solenoids and the extra coil, D. These shunt turns on the solenoids, A and B, are wound so as to tend to demagnetise the core, opposing the action of the main current. The shunt current therefore tends to make the core release the clutch and lower the top carbon holders. When the lamp is in its normal working condition the force of the shunt winding is insufficient to act on the clutch; but as the carbons burn away the distance across the arc and the resistance of the arc will increase. Notwithstanding this, the dynamos will maintain a constant current in the line. So there must necessarily be a greater and greater rise of volts at the terminals of the lamp, and an increasing shunt current as the arc grows longer. Presently the shunt current overpowers the main current and the core releases the action of the clutch on the carbon holders and the top carbons are fed down. In order to prevent violent motion of the carbon holder as it is fed down, or during striking, the upper ends of both the top holders are formed into glycerine dash-pots. The extra coil, D, is provided to cut out the lamp if the carbons cease to permit a current to pass. Should the arc be interrupted a very considerable rise of pressure will take place at the terminals, owing to the tendency of the dynamos to maintain a constant current in the line. It would be both wasteful and injurious to the lamp to permit of so much current passing for more than a short time through so high a resistance as that of the shunt coil; and the dynamo would be unable to keep up the proper current if several lamps should happen to be in this state at the same time. To rectify matters the faulty or exhausted lamp is short-circuited by the device, D and E. The shunt current is carried round the coil, D, and attracts the lever, E. When the arc is stopped the shunt current is strong enough to overcome the weight of the lever and to lift it into con-

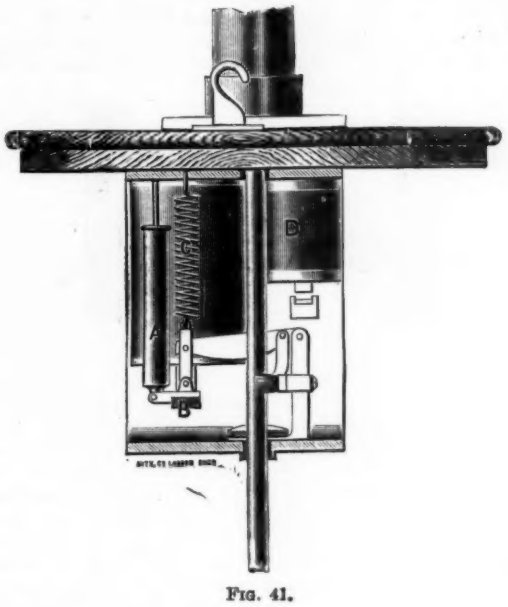


FIG. 41.

tact with the metal surface, G, thus, as will be seen, placing a low resistance shunt across the terminals. This low resistance shunt takes a few turns round the solenoid, D, in order to maintain the magnetic force necessary to hold up the lever, E. In fig. 41 the Brush lamp is shown with its back cover removed; and a cross-section of the mechanism is shown in fig. 42. The cut-out solenoid is indicated by

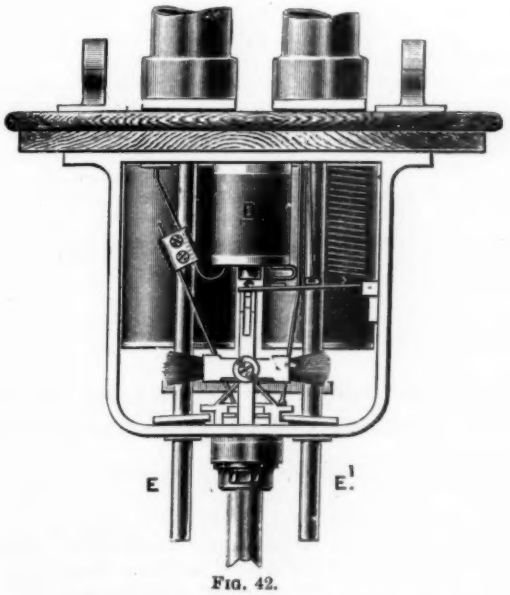


FIG. 42.

D; and a dash-pot regulator for the clutch is shown at A, the tension regulating spring of the clutch being marked C. Current is led into the lamp by means of the two stout metal hooks which are shown at the top of the diagrams; and it is conducted to the carbon holders by means of two small brushes of copper wire, placed near the bottom of the mechanism case.

The arrangement of the clutch, and its action in raising

or lowering the carbons, will be explained by reference to fig. 43. The clutch, K, is raised or lowered by the core, C, (fig. 40), and R_1, R_2, are the brass rods which hold the top carbons. Round each rod is a loose washer, W_1, W_2. When the lamp is not in action these washers rest horizontally on the bottom of the mechanism case, and the holders can slide through them till both pairs of carbons are in contact. But when the clutch, K, is raised it tilts both the washers in the fashion shown at the right hand washer in fig. 43, and by this means it raises the two carbon holders, R_1, R_2. The right jaw of the clutch is, however, a little higher than the left jaw, so that the right washer is tilted and lifted a little

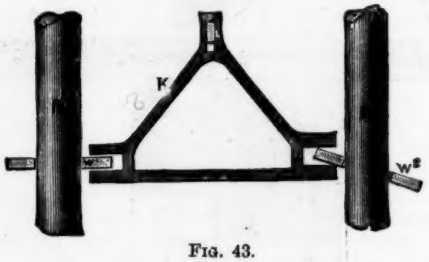


FIG. 43.

before the left one; the current continuing to flow through the left pair of carbons after the right ones have been parted. No arc is therefore struck at the right pair of carbons; but a moment later when the left pair parts, the arc is struck and all the current passes through this pair till they are consumed. When quite burned out, the left pair will momentarily interrupt the current, but the prompt action of the shunt coil will cause the clutch to be lowered, and the right hand washer now coming into contact with the bottom of the case will be thrown out of its tilted state and will release the right hand pair of carbons. When these come into contact a sudden rise of the clutch, due to the main current being re-established, will strike the arc on the second pair of carbons. The rods, R_1, R_2, are hollow, and are filled with glycerine. Within each rod is a plunger attached to the top of the lamp, so that as the rods rise or fall, a considerable damping effect is produced by the dash-pots thus formed. In this lamp, besides the automatic cut-out, there is a hand switch for short-circuiting the lamp as occasion may require.

Considering this lamp as typical of the class, we may notice the following general points in its design :—(*a*) The striking is effected by a series or main coil. (*b*) The feeding is effected by a shunt coil. (*c*) The carbons are initially in contact, and will tend to become so whenever the current is stopped. (*d*) The cut-out device *short*-circuits the lamp, and under no circumstances will a good lamp be open-circuited. (*e*) The crater is formed on the top carbon. (*f*) The motion of every part is moderated by suitable dash-pots, so that violent motion or "hunting" may be prevented. Hunting, or the oscillation of a regulating gear to and fro on account of over-regulation, produces in an arc lamp a pumping light.

(To be continued.)

THE IMPEDANCE OF MUTUALLY INDUCTIVE CIRCUITS CONTAINING CAPACITIES.

BY E. C. RIMINGTON.

IN the New York *Electrical World* for October 21st, 1893, Mr. Kennelly has an article on the treatment of mutually inductive circuits by a graphical method. In a paper on "The Behaviour of an Air-Core Transformer when the Frequency is below a Certain Critical Value," recently read by the writer before the Physical Society, a geometrical method is employed which, with but slight modification in the case of capacity, gives a method somewhat similar to Mr. Kennelly's, but which the writer ventures to think is even simpler. In the following it is proposed to discuss the above method and the modification necessary when the primary or secondary circuit contains capacity, or when both do so.

Let r_1 be the resistance of the primary circuit, L its self-inductance, r_2 the resistance of the secondary circuit, N its self-inductance, and M the mutual inductance of the two circuits.

Let C_1 and C_2 be the maximum values of the primary and secondary currents, and $p = 2\pi n$, where n is the frequency.

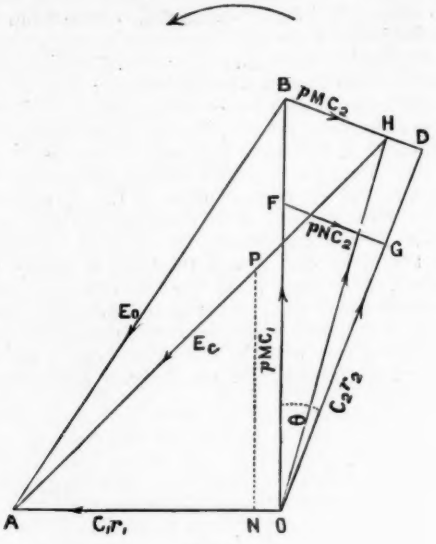


FIG. 1.

Draw a straight line O A $= C_1 r_1$ and O B at right angles to it and equal to p L C_1, then A B represents the impressed P.D. at the primary terminals necessary to give a maximum primary current, C_1; when the secondary is absent, call its value E_0. Draw O D, making an angle θ with O B, where $\theta = \tan^{-1}\frac{p\,N}{r_2}$, this can be easily obtained from a table of tangents.

In O B take a point, F, such that $\frac{O\,F}{O\,B} = \frac{M}{L}$.

Drop the perpendiculars F G and B D into O D. O F $=$ O B $\times \frac{M}{L} = p\,L\,C_1 \times \frac{M}{L} = p\,M\,C_1 =$ the E.M.F. acting in the secondary, due to the induction in the primary.

Hence, O G $= C_2 r_2$ and F G $= p\,N\,C_2$.

Now $\frac{B\,D}{F\,G} = \frac{O\,B}{O\,F}$, hence B D $= p\,N\,C_2 \times \frac{L}{M} = \frac{p\,L\,N}{M} C_2$.

In B D take a point, H, such that $\frac{B\,H}{B\,D} = \frac{M^2}{L\,N}$.

Then B H $= \frac{p\,L\,N}{M} C_2 \times \frac{M^2}{L\,N} = p\,M\,C_2$ or is the E.M.F. in the primary due to the reaction of the secondary. Join O H and A H.

There are then two E.M.Fs. in the primary due to induction, viz.: O B* the E.M.F. due to self-induction, and B H due to the reaction of the secondary. Now the resultant of these two is O H.

Again, O A is the resultant of O H and H A, but O A represents the effective E.M.F. in the primary or $C_1 r_1$, and O H represents the resultant E.M.F. due to induction, consequently H A must represent the impressed P.D., or E_c when the secondary is present.

Call I_1 the impedance of the primary when the secondary is absent, and I its apparent impedance when the secondary is on. Then $\frac{I}{I_1} = \frac{E_c}{E_0}$, since the primary current is C_1 in both cases.

If, moreover, we had drawn O A equal to r_1 and O B equal to p L, the rest of the diagram being drawn by the same construction as before, A B would have represented I_1, hence

* The arrows show the direction of these vector quantities.

A H would represent I; so that if the diagram is drawn to scale the values of I and I_1 can be obtained by the measurement of the lengths O H and O B. In practice the point, F, and the line, F G, need not be drawn, all that is necessary being to draw O A $= r_1$, O B at right angles to it $= p$ L, O D making an angle equal $\tan^{-1} \frac{p\,N}{r_2}$ with O B, drop the perpendicular B D and take $\frac{B\,H}{B\,D} = \frac{M^2}{L\,N}$, and join A H (see fig. 2).

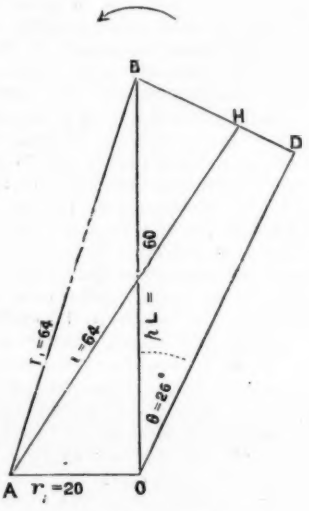


FIG. 2.

In fig. 2 an example has been worked out to scale.

$r_1 = 20^{\omega}$ L = ·2 henry

M = ·08 henry

$r_2 = 30^{\omega}$ N = ·05 henry

$n = 47{\cdot}7 \sim$, so that $p = 2\pi n = 300$

$p\,L = 60$ $p\,N = 15$ $\frac{p\,N}{r_2} = \frac{15}{30} = {\cdot}5$

so $\theta = \tan^{-1} {\cdot}5 = 26°$ about.

$\frac{M^2}{L\,N} = \frac{{\cdot}08^2}{{\cdot}2 \times {\cdot}05} = {\cdot}64$, so that B H = ·64 B D.

A B or I_1 comes by actual measurement to 63·25. A H or I also measures about the same, that is to say with the figures taken the primary impedance remains practically unchanged when the secondary is closed.

We must now consider how the above will be modified when there is capacity in one or both of the circuits.

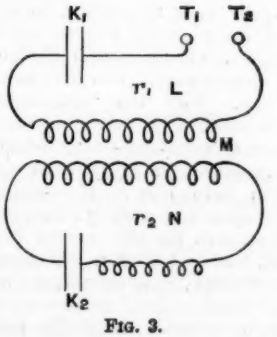


FIG. 3.

Let K_1 be the capacity in the primary circuit and K_2 that in the secondary, arranged as shown in fig. 3, the primary P.D. being established between the terminals T_1 and T_2.

Now it is well-known that capacity behaves like a negative self-induction equal to $\frac{1}{p^2\,K}$, so that in fig. 1 O B must represent $\left(p\,L - \frac{1}{p\,K_1}\right) C_1$, instead of $p\,L\,C_1$, and

$$\theta = \tan^{-1} \frac{p\,N - \frac{1}{p\,K_2}}{r_2}.$$

Now there are four cases to consider :—

1. When $p\,L - \frac{1}{p\,K_1}$ is positive and $p\,N - \frac{1}{p\,K_2}$ is positive.

2. When $p\,L - \frac{1}{p\,K_1}$ is positive but $p\,N - \frac{1}{p\,K_2}$ is negative owing to $\frac{1}{p\,K_2}$ being greater than $p\,N$.

3. When $p\,L - \frac{1}{p\,K_1}$ is negative and $p\,N - \frac{1}{p\,K_2}$ positive.

4. When $p\,L - \frac{1}{p\,K_1}$ and $p\,N - \frac{1}{p\,K_2}$ are both negative.

The first case will be identical with that considered in fig. 1, only instead of $p\,L$ and $p\,N$, we must take the values $p\,L - \frac{1}{p\,K_1}$ and $p\,N - \frac{1}{p\,K_2}$, also B H will equal $\frac{p^2\,M^2}{\left(p\,L - \frac{1}{p\,K_1}\right)\left(p\,N - \frac{1}{p\,K_2}\right)} \times B\,D = a \times B\,D$, where $a = \frac{p^2\,M^2}{\left(p\,L - \frac{1}{p\,K_1}\right)\left(p\,N - \frac{1}{p\,K_2}\right)}$

In the second case, make O A (fig. 4),* equal to r_1, and O B $= p\,L - \frac{1}{p\,K_1}$.

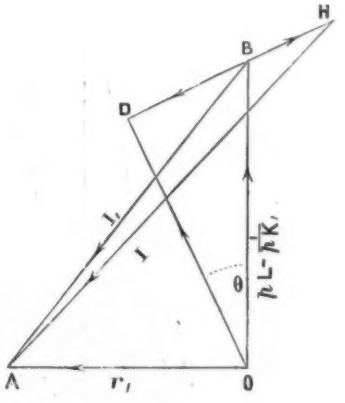


FIG. 4.

Now $\theta = \tan^{-1} \frac{p\,N - \frac{1}{p\,K_2}}{r_2}$ and is a negative angle, so O D must be drawn making an angle, θ with O B, the reverse side to what it did in fig. 1. Drop the perpendicular B D on O D as before. Now as B D is negative (since $p\,N - \frac{1}{p\,K_2}$ is negative) and B H is positive (since $p\,M$ is positive), B H is the reverse sign to B D.

Hence produce D B to H, making B H = B D multiplied by the numerical value of a.

Join A H, then A H represents, as before, the apparent impedance of the primary when the secondary circuit is present, and A B $= I_1$, the impedance with the secondary open.

* The arrows in fig. 4 are the directions of the vectors in the corresponding diagram of E.M.Fs.

It should here be noted that, while in the case of no capacity B H must be less than B D, since M^2 is always less than L N on account of magnetic leakage, in the present case B H may be greater than B D, since M^2 may be greater than $\left(L - \frac{1}{p^2 K_1}\right)\left(N - \frac{1}{p^2 K_2}\right)$ or a greater than unity; the same remark applies to the first case, that is H, in fig. 1, may be in B D produced, also to all the further cases.

This second case is the one considered by Mr. Kennelly in his paper, and he works out an example with the following figures:

$r_1 = 20^\omega\ r_2 = 50^\omega$ $L = \cdot2$ henry $N = \cdot05$ henry $M = \cdot05$ henry

$K_1 = 10^{-5}$ farad $K_2 = 10^{-5}$ farad $p = 2\pi n = 1{,}000.$

$$\text{Then } p L = 200 \quad \frac{1}{p K_1} = 100 \quad p L - \frac{1}{p K_1} = 100.$$

$$p N = 50 \quad \frac{1}{p K_2} = 100 \quad p N - \frac{1}{p K_2} = -50$$

$$\tan\theta = \frac{p N - \frac{1}{p K_2}}{r_2} = -\frac{50}{50} = -1, \text{ or } \theta = -45°.$$

$$a = \frac{p^2 M^2}{\left(p L - \frac{1}{p K_1}\right)\left(p N - \frac{1}{p K_2}\right)} = \frac{10^6 \times \cdot0025}{100 \times (-50)} = -\tfrac{1}{2}$$

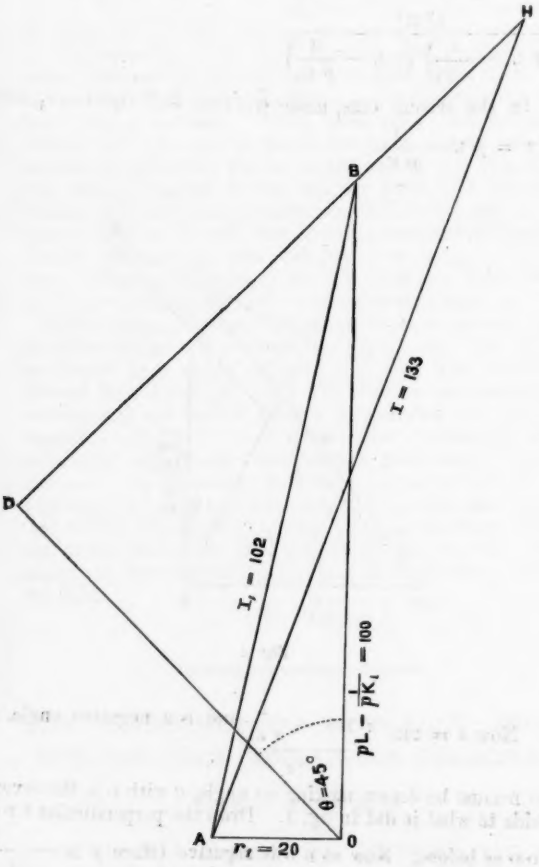


FIG. 5.

Fig. 5 is the above worked out to scale, and B H $= \frac{B D}{2}$

I_1 gives by measurement, 102 as its value, and I, 133.

In the third case, $p L - \frac{1}{p K_1}$ is negative.

(To be continued.)

THE PHYSIOLOGICAL EFFECTS OF HIGH FREQUENCY ELECTRIC CURRENTS.*

BY W. S. HEDLEY, M.D.EDIN., M.R.C.S.ENG.

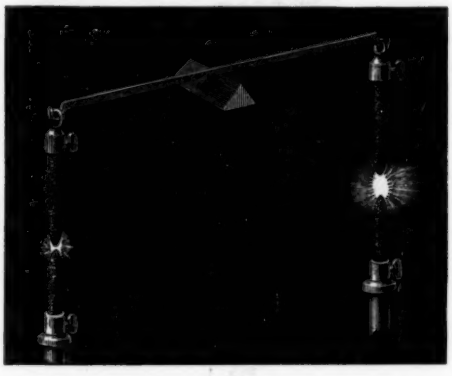
MR. A. C. SWINTON'S letter in the *Lancet* of October 14th will not only be appreciated by medical men as a valuable contribution to our knowledge of a new and difficult subject, but it will be accepted also as an indication that the electrical expert is willing to aid in the efforts of the profession to decharlatanise medical electricity, and to reduce some at least of its problems to a question of sound physics. In referring to an article of mine which appeared in the *Lancet* of August 19th, Mr. Swinton correctly states that the view therein adopted that high frequency currents are harmless, mainly because of their small current strength, is one previously put forward by him in the *Philosophical Magazine* of February last. It might also have been added, and no doubt would have been so, had Mr. Swinton been aware of the fact that before the appearance of the article in the *Philosophical Magazine*, I, and before me the ELECTRICAL REVIEW, had accepted this principle, and referred to the "whittling down" of current strength by the various transformations to which it had been subjected as a probable cause of this and many similar phenomena. This seems to be evidenced by an article on the physiological effects of alternating currents published in the *Lancet* of December 24th, 1892, and by the pages of the ELECTRICAL REVIEW. With the knowledge that exists of the surface transmission of high frequency currents along metallic conductors, Mr. Swinton's explanation of the power of such currents to light incandescent lamps become a very probable one; but when the human body becomes the conductor, there seems to be no good evidence to show how such currents are transmitted unless (and this the present state of the question seems scarcely to warrant) the physiological effects claimed for them are accepted as a proof that they deeply penetrate the organism. This is a question in biological physics concerning which light and leading are still sought for. Mr. Swinton suggests a general law that, apart from some possible minor influences of frequency and abruptness of alternation, the physiological effects of electric currents are mainly proportional to their electrolytic effects. Other things being equal, this is probably true. But it seems to minimise the importance of other factors, and, taken as a law, to fall far short of the facts. As an instance, those most obvious of all electro-physiological phenomena, the neuro-muscular effects that follow electric excitation, may be cited. Putting aside for the moment the influence of current density, an old and familiar experiment, in which a voltameter, an interrupting wheel, and a frog à la Galvani ("physiological limb") are connected up in a continuous current circuit, may be considered. With the wheel at rest gas is disengaged and there is no visible muscular contraction. Once the wheel is put into motion evolution of gas nearly ceases, and the muscle is seen to strongly contract. In other words, unless a certain current is made and broken no visible muscular movement occurs. The mere passage of the current, be the electrolytic effect what it may, fails to produce visible contraction. Here motor reaction is proportional to the *variation* of the potential and to the suddenness with which that variation is made, as well as (no doubt) to the strength of the current used. But the question is not even so simple as this. With the "interrupted Franklinic" current there is obtained a maximum motor effect with a minimum amount of sensation—viz., violent muscular contraction with practical immunity from pain. How does current strength help here? If smallness of quantity accounts for the absence of sensory effect, it can scarcely be invoked also to account for the marked presence of motor effect. Further, how does such a law cover the phenomena of "make" and "break," and the reversal of the formula in the "reaction of degeneration," or how does it account for those conditions of altered excitability known as "anelectrotonic" and "katelectrotonic?" In these cases there are varying physiological effects with the same current strength. How far the ordinary laws of physics, and how far "vital" endowments of living structure account for such phenomena,

* The *Lancet*.

has yet to be ascertained. It would appear that we must still content ourselves with the statement that the effects of electric currents on the body depend not only upon current strength, but on the *mode* in which such current strength is presented, *i.e.*, that physiological effects are proportional not only to the *quantity* of electricity, but also to its *modality*.

THE SEE-SAWING OF ARC LAMPS.*

WHERE arc lamps are run two in series on incandescent circuits, much annoyance has been caused by their interfering with each other's regulation, the result being an alternate feeding and separating of the carbons, which has been termed "see-sawing." For those who do not wish to go into theory of this action, the simple analogy in the accompanying cut may be interesting. It will be remembered that all lamps of this class have the feeding mechanism controlled by two magnets, one being on the main circuit and in series with the arc itself, while the other is a shunt around the arc. Then as the carbons burn away and the arc lengthens, the comparative resistance of the two paths for the current changes, and allows the lamp to feed the carbon. In the case of series lamps the main current is kept practically constant by the dynamo or its regulator, and the voltage at the lamp varies.



But with a pair of lamps on a constant potential circuit the sum of the voltages remains unchanged, so that the increased consumption at one lamp will rob the voltage from the other, and *vice versâ*. In other words, the left hand arc in the cut will have very little counter-electromotive force, so that most of the voltage will be left for the other one, and will draw the right-hand pair of carbons far apart. But this action exaggerates the difference in voltage still more, until the left-hand arc touches its carbons and then separates. In this way one pair of carbons will approach while the others are separating, the action being just as if they had a mechanical lever suspension as pictured. Mr. George Cutter, of Chicago, holds this matter of see-sawing to be one of the greatest problems met in adapting arc lamps to incandescent circuits, but he thinks it is well met by the peculiar design of the Waterhouse lamps, and it is said that users bear out his statement. At any rate the pictured analogy is interesting, as showing a drawback which has at last been overcome.

EXPERIMENTS ON BROWN'S ASYNCHRONOUS MOTORS.

IN February of this year, when C. E. L. Brown published the particulars of a motor with a monophase, asynchronous current, for which he had obtained a patent shortly before, there arose disputes concerning priority on the part of some scientists. Elihu Thomson, Hutin and Leblanc, Arnold, and the Oerlikon firm, maintained this delicate question in various directions. The matter was taken up merely to show what importance was attached to Brown's discovery, and how great such results always might be, such researches were undertaken for a type of motors which represents a decisive victory in the old struggle between the continuous and the alternating currents. Now we are able to say that it not only permits the easy transformation of mechanical energy into light, but that it has solved in its most general form the problem of the transfer of electrical energy, capable of being utilised at once in the form of light and of motive power.

The principle on which the motor constructed by Brown is founded is as follows:—Suppose that between the arms of an electro-magnet is placed a metallic disc, opposite to which is a drum armature with closed coils. If an alternating current is passed into the circuit of the electro-magnet, so as to form of the two arms two magnetic poles, alternately north and south, and of an intensity periodically variable at once in the metallic disc or its armature, there are excited induced currents immersed in the magnetic field generated. These currents, as long as the armature is left at rest, do not occasion any rotatory movement, but as soon as by any means there is impressed upon them a movement synchronous with that of the inducing field, this movement is permanent. On compelling, then, the armature, *e.g.*, to overcome a given force, the movement will be retarded, but there will be developed in equal time a couple to support the greater force.

To estimate this view, various analytical studies were published in those days. It is only necessary to indicate those of Hutin and Leblanc, who have repeated a calculation published by them at the end of May, 1891; those of Sahulka, De Baot, of A. and J. Boissonas, and the most recent calculations by Boncherot. Both in the calculations of Hutin and Leblanc, initiated on account of a motor of their invention, and in those of Sahulka, adapted for an ideal motor of Brown's type, it is found that the function which connects the couple being developed to the shaft of the motor with its velocity can be represented by a line as in fig. 1, in which the ordinate, C, represents the mean couple developed, and the abscissa, m, represents the corresponding velocity.

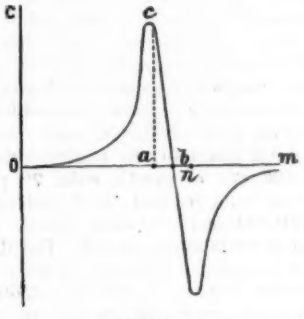


FIG. 1.

Hence it is deduced that the motor force is nil at a velocity $m = 0$, increasing with it, reaching a maximum for $m = 0\,a$, falling suddenly to zero for a value of velocity $= 0\,b$, and becomes negative for values increasing from this point. Observing, then, that this velocity, $0\,b$, is a little inferior to that of $0\,n$, at which the keeper of the motor rotates synchronously with the inducing wheel, it is inferred: 1, that when the motor proceeds synchronically, that is, with the speed, $0\,n$, the value of the motive couple is already negative; 2, that for a certain velocity, $0\,b$, very near synchronism, the motive couple is nil; that for values of the velocity, still a little less than $0\,b$, and near to $0\,n$, there exists the positive maximum of the couple.

It does not follow that the motor cannot act at the values of the velocity comprised between 0 and a, since on augmenting the load, the movement will tend to slacken and to develop in consequence an always smaller couple, and finally stopping. It will not act at values of the velocity higher than $0\,b$, evolving then a negative couple, since the field within which the motor can regularly evolve its action will be reduced to the values of the velocity comprised between a and b, corresponding to the positive descending arm, c, b, of the curve.

This leads to the objection that a motor of this kind cannot be an industrial motor.

* New York *Electricity*.

But it must be observed that the calculations from which the foregoing considerations issue, arise from special hypotheses on the constitution of the armature of the motor, and will be very different if it is properly constructed. The foregoing objection has no serious importance when the tract, *a*, *b*, of the axis of the abscis yields results sufficiently great to comprise all the values of the velocity which the motor may assume in practice, whatever the force which it has to overcome, from zero to a value much greater than that for which the motor is constructed.

However, leaving aside such analytical considerations which, in the actual state of the question, cannot lead to any satisfactory practical result, interest will attach to the following experiments which have been executed upon some of these motors, so as to give a fair account of their behaviour.

(To be continued.)

ELECTROLYTIC CHRISTMAS-BOX.

A BENEVOLENT undertaking, the Electro-Chemical Company, has been formed in the interests of the British public. This company, says the preliminary prospectus, *will be able, under any circumstances, to afford to sell at lower rates than the United Alkali Company, its great competitor, sulphuric and hydro-chloric acids, salt cake, soda ash, caustic soda, bleaching powder, chlorate of potash, &c.*

The Richardson-Holland process, which is owned by the Electrolytic Caustic Soda and Chlorine Trust, "is," adds the prospectus, "probably the most efficient, compact, cleanly and profitable for the manufacture of caustic soda and bleach."

The capital of the Electro-Chemical Company is £350,000, in 70,000 shares of £5 each; the present issue is £200,000, of which 12,000 will be issued as fully paid to the Electrolytic Caustic, Soda and Chlorine Trust, Limited, in *part payment for the British patent rights* sold to this company, and the directors "confidently appeal to all users of chemicals to invest in and *cordially* support their company, which, in addition to paying high dividends, must tend to prevent further artificial inflations in the market prices. To turn out annually *7,400* tons of caustic soda, 70 per cent., and *9,860* tons of bleach, 36 per cent., with buildings and land, they require *£80,000*, and they estimate that *£20,000* will be amply sufficient for working capital. The Richardson and Holland *British patents* belonging to the Electrolytic Caustic Soda and Chlorine Trust are sold for *£100,000*, payable *£60,000* in fully-paid shares of the new company, and the *£40,000* remaining in cash.

What is rather puzzling is that this prospectus speaks of the production of *7,400* tons of caustic soda, and *9,860* tons of bleach only per annum. This represents, in round figures, a daily output of *25* tons of caustic soda and *33* tons of bleaching powder; but as three tons of *bleaching powder represent 1 ton of chlorine*, the production will only be of *11* tons chlorine per day. How can this be conciliated with Dr. John Hopkinson's statement that *2 tons of common salt* should yield *1·07 ton of anhydrous caustic soda*, and, *in addition, 1·2 ton of chlorine gas* for every electrical H.P. applied per annum? *1 2* ton of chlorine gas are equivalent to *3·3 tons* of bleaching powder containing 36 per cent. of chlorine; the 9,860 tons of bleaching powder show that the Electro-Chemical Company will produce only *11 tons of chlorine* per day. There seems to be, therefore, a great discrepancy between the daily production of soda and of chlorine; the only explanation we can suggest is that very little chlorine and soda will be manufactured by electrolysis, and that this Electro-Chemical Company might be more a chemical than an electrolytic concern.

Although we have not, for the present, any intention of criticising this scheme, we cannot help thinking that £100,000 is a heavy price, and that if some competitor or competitors bring on the market a better or cheaper process for the electrolytic production of chlorine and caustic soda, the shareholders will remember their 1893 Christmas box. A final remark on the prospectus: "Subscribers for shares will be deemed to have waived any rights they may have to particulars, whether under section 38 of the Companies Act, 1867, or otherwise, in relation to contracts or arrangements for the subscription of the capital of this company." This clause may be usual among promoting people, and we find in the Caustic Soda and Chlorine Syndicate prospectus (Greenwood process) a similar statement, with the addition of these few words: *and to accept the above statement as sufficient compliance with that section* (38th).

THE PYKE AND HARRIS CONTINUOUS CURRENT DYNAMO.

MESSRS. PYKE, HARRIS & CO., LIMITED, are introducing a continuous current dynamo-electric machine, illustrated in fig. 1, which, in common with other things "under the sun," may not be wholly new, but is stated to possess more points of novelty than would ordinarily suffice for half-a-dozen so-called "new designs," now that the scope of possibilities in connection with improvements in dynamo-electric apparatus has become so very limited.

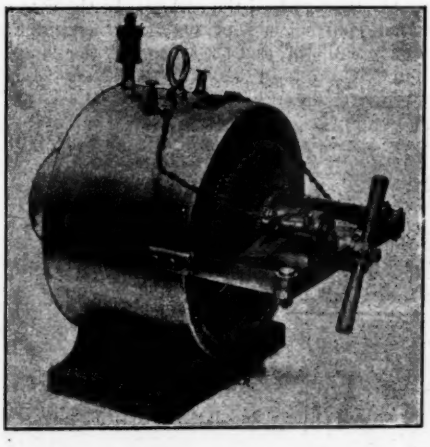


FIG. 1.

The field magnet is of the same enclosed coil type that the firm are using in their well-known inductor alternator. The machine is, of course, self-exciting; in the small experimental machine, which is of only 6 kilowatts output, as small a proportion of 1½ per cent. of the total current produced suffices for the production of the necessary magnetic field, the high efficiency of this part of the dynamo being no doubt due to the field coil being completely surrounded by a very solid mass of wrought-iron.

From the reproductions of photographs produced herewith, it may be seen what is the precise nature and disposition of the arrangements, but in addition it may perhaps be stated that the field magnet consists of an annular coil of insulated conductor surrounded with wrought-iron, except for a zone on one side, in the centre of which annular aperture, revolves the armature, the remainder of the space between the armature and the field magnet being reserved for the six pole pieces, which are composed of charcoal iron laminæ, secured to one another and to the field magnet by brass rivets and brackets.

Fig. 2 is a plan of the polar arrangement of the field magnet; it will be seen that in contradistinction to other multipolar machines, the poles are so placed, that no matter how much out of the centre of the gap the armature may be, either by reason of direct carelessness, or of unequal wear of the bearings (usually the result of indirect carelessness), the total air space between the N. and S. poles in every part of the magnetic field will necessarily be equal, nor can there be any unequal magnetisation of the field poles themselves, as they are all part of a single field magnet.

Thus is abolished at one stroke all the difficulties experi-

enced with multipolar "continuators," concerning which complaints have been so loud and frequent; there can be no trouble with the armature, under the heads of either heating or sparking, without unequal magnetisation and consequent want of balance in the E.M.Fs. produced in the various sections of the armature, each of which lies between a pair of oppositely magnetised field poles. The armature is of the Pacinotti ring type, and is composed of annular soft iron laminæ bolted together, and to a disc-shaped carrier plate situated on one end of the shaft.

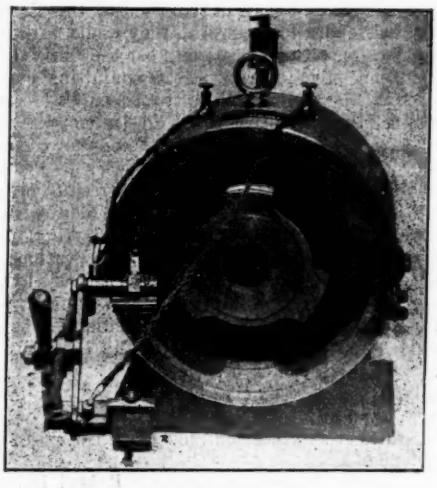


FIG. 2.

As illustrated in fig. 3, the armature appears to be somewhat deficient in iron; actually the ring has a sectional area more than half as large again as shown, and it fills the annular gap save for a space of $\frac{3}{4}$ inch beyond its inner and outer surfaces partly occupied by the field poles.

The brushes, carried on a swing bracket, are opposite to one another, as in a two-pole machine; the hinged bar which carries them may be instantly withdrawn from across the commutator, so that if necessary the armature may be taken off at any time, and another one put on with the greatest ease and expedition

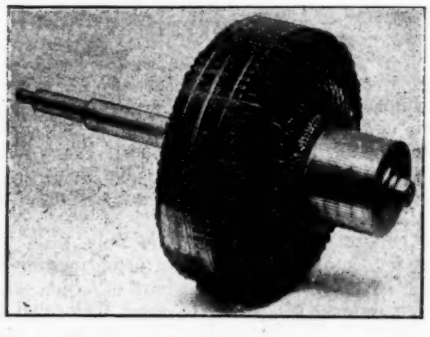


FIG. 3.

There is one point about the machine which requires explanation, and that is, that while the armature is of the Pacinotti type ordinarily (not Sayers) wound, and the number of commutator segments (in proportion to the E.M.F.) is small, no sparking is discernible, and with constant load the arc through which the brushes may be moved, and the variation in load that is permissible without altering the position of the brushes, is considerable. These machines should be particularly suitable for furnishing both continuous or alternating currents, and when required for that purpose will carry additionally contact rings for the alternating current collectors upon and insulated from the shaft beyond the continuous current commutator.

It is to be hoped that Messrs. Pyke & Harris will follow up this experimental machine with some large commercial models, and it will be interesting to observe what careful tests prove the machine to be worth economically.

The following figures have been furnished us relating to the dynamo illustrated:—

Output, 100 volts 60 ampères; revolutions per minute, 800; over-all dimensions—height, 21 inches, length, 20 inches, width, 15 inches, approximate weight, 7 cwt.

CORRESPONDENCE.

Fuel Economy.

Your article of the 1st inst. on "Fuel Economy" deals with a subject of vital importance in the development of electrical supply, and you very aptly point out the much greater extent to which it is so, than even in the case of pumping operations. Your account of the utilisation of tan bark for the purpose simply of preventing too great density in the bituminous fuel employed is very interesting, but I venture to suggest that it would have been still more so if a statement had been given of the ultimate power of the boiler with such fuel; that is to say, the total amount of steam generated as compared with that obtained when using coal *with the same force of chimney draught.*

You remark that "it is by no means the case that these cheap mixtures cannot be fired by hand when the grate area is sufficient;" no doubt they can be so employed, and to me it seems that the fact of a large grate area being required goes to show that the difficulty in burning them consists of the inability to get sufficient air through the entire mass, and may not necessarily show that if sent through in sufficient volume it will not reach every particle of combustible.

With respect to hand firing. I had occasion about two years ago to endeavour to obtain mechanical stokers for dealing with a very large amount of coke breeze which is being burned under a range of boilers in a Continental city, but I found that none of the prominent makers would undertake to supply mechanical stokers for the purpose.

The mechanical stoker can, I presume, never be of great service for electric light purposes, where the steam requirements vary constantly and very largely, while mechanical stoking is at its best where a constant supply is desired.

Coke breeze can be stoked by hand and burnt without difficulty by means of Meldrum's apparatus, as is evidenced by many hundreds of boilers in gas works and various factories, which are employing it in that manner; its calorific value may be put at about 6½ lbs. of water evaporated to each 1 lb. of fuel burnt. I may say that although I have seen a large number of boilers burning unmixed coke breeze, I have not found but that the draught as provided by this appliance reaches, and enables the whole of the combustible to be consumed. Coke dust, however, is not to be procured in sufficient quantities to enable electric light stations to be run with it, although in many cases it might probably be advantageously employed while the plant is running light, and coal used when the heavy load comes on.

Small anthracite coal offers the advantage of being absolutely smokeless, and having a high calorific value as well, it requires a forced draught; and I may say that I have found rough slack, *i.e.*, screenings, as distinct from broken and washed "peas," to be quite as efficient and cheaper than the latter. Even in the use of good Welsh and the better class of anthracite coal, economy is to be effected by dealing properly with the draught, and I take it that it is really the draught which is the root of the matter. Why should the engineer perform all his other operations by mechanical means which are perfectly under control, and leave the important question of the boiler draught at the mercy of the wind and weather? Surely the draught of his boiler is the beginning and essential feature of his steam supply, and he ought not to be in the position that a delivery of bad coal, or a wet or foggy day, may cause him to be short of steam. I am not condemning our old friend the tall chimney, far from it, although the time may be coming when its altitude will be reduced, and when a mechanical appliance for regulating the draught will be regarded as a necessity almost as great as the governor on the engine. At present the state of affairs often is that, with full load, the boilers are working with the dampers wide

open, and nothing more in the way of draught can be obtained; if, then, any accident happen, so as to temporarily disable one boiler, or any other cause render an extra supply of steam desirable, the only resource is the bad one of hard "stoking;" how much better must be the system illustrated in your issue of September 8th, where, by means of the appliance there described, as in use with Babcock boilers, a combustion equal to about 60 lbs. of coal per square foot of grate per hour could, if necessary, be obtained simply by an alteration of the draught. By means of this same appliance, the urban authorities of Basingstoke are now pumping 274,000 gallons of sewage per day of 9 hours, 100 feet high, with a consumption of 23½ cwt. of house refuse, crude as it comes from the house bins, except that the tins and pots are removed, and dust shaken out of it in a riddle, with bars $\frac{3}{16}$ths inch apart. This is an instance of a good draught dealing with probably the poorest class of material used as fuel.

William Boby.

December 13th, 1893.

Hedgehog Transformers and Condensers.

Our attention has been drawn to your recent issue, in which you give an abstract of a paper read before the American Institute of Electrical Engineers; at the conclusion of this abstract, the authors are made to express the opinion that "The experiments with the condensers demonstrate the practicability of their use to diminish the line-current in transformer circuits, and point to their more extended use, as their manufacture is perfected and cheapened, not only in this, but also in other systems of alternating current distribution." As the paragraph implies the non-existence of any practical condenser, we point out that we have ourselves been manufacturing condensers commercially for the last two years (under the Swinburne patents) principally for Germany; and out of the total number supplied by us in this time, only one has been returned broken down. We think, therefore, we are fairly justified in claiming to have solved the problem of condenser manufacture.

The Stanley condensers used in these tests were made with waxed paper, a method discarded by us several years ago as quite useless for practical engineering work.

Swinburne & Co., Limited,
B. W. BEALE, *Managing Director.*

Count Mattei's Remedies.

I have read Mr. A. J. L. Gliddon's letter in your current number with interest, and note his comment on my previous communication. It seems curious that in so exact a science as chemistry such an error as he alleges should take place. But, be that as it may, it is a great pity that Count Mattei's friends in this country do not submit his remedies for cancer to the test of a practical trial, under the superintendence of some well-known surgeons. There are, unfortunately, no lack of victims to this terrible disease, and I feel sure that it would be easy to secure subjects for such a trial. In English practice, it is not professional, I believe, for medical men to conceal the ingredients of any new remedies they may discover, on the ground that such knowledge should not rightly be kept from suffering humanity at large. Count Mattei acts on a different flow, preferring to sell his concoctions at a profit. That is his affair, however; but it would surely do much to increase his trade if he would subject his potions to searching trial in an English hospital, as if he can really cure cancer, hundreds would turn to him as a saviour of mankind. Is it quite politic, even from a business standpoint, to neglect to satisfy the medical profession in this matter? and, if it is, I should be glad if Mr. Gliddon can tell me why it is so.

Howard Tozer.

Northampton, *December 16th*, 1893.

Mr. Robert Hammond's Explanation.

Your comments on my position with regard to the electric light contract at Coventry, made in your last issue, are based upon absolutely wrong assumptions. Allow me, therefore, to furnish you with the real facts, in order that you may be enabled to draw the right conclusions.

On October 28th, 1892, I, jointly with Messrs. John Fowler & Co. (Leeds), Limited, sent in a tender to the Coventry Corporation. Later on, however, and whilst the Electric Light Committee was engaged in the consideration of the several tenders, I decided to cease doing business as contractor, and to confine myself solely to the work of consulting engineer. A circular to that effect was sent out by me on September 15th of this year.

Before issuing this circular, I requested the Electric Light Committee of Coventry to allow me to retire from the joint tender, and I was told that, in the event of the Corporation selecting that tender for approval, they would wish to stipulate for my co-operation in carrying out the work.

Thereupon I offered my services as consulting engineer to the Corporation, and explained to them that, since my previous arrangement with Messrs. Fowler entitled me to a remuneration of 5 per cent. upon the amount of the contract, if obtained, I would require Messrs. Fowler to deduct that sum from their tender. Messrs. Fowler agreed to my request, and very naturally, since it made no difference whatever to their prospective profits. On this understanding, and after having been advised by Mr. Preece upon the various tenders submitted, the committee reported to the Corporation, recommending the adoption of Messrs. Fowler's tender, with the deduction above mentioned, and my appointment as consulting engineer to the Corporation for the execution of the works, at a commission of 5 per cent.

Finally, I beg to state, that having given up all contracting work, my position with regard to Messrs. Fowlers, and with regard to every other contracting firm, is one of absolute independence.

Robert Hammond.

[The proceedings related by Mr. Hammond confirm our view of the impropriety of appointing a consulting engineer to supervise the work of a co-tenderer, and of thereby reducing the amount of one tender and giving it an advantage over other tenders for the same work. The close relationship to which we referred is sufficiently proved by the circumstances related by Mr. Hammond. Perhaps we shall have something further to say on this matter later on.—EDS. ELEC. REV.]

WOODHOUSE & RAWSON UNITED, LIMITED.

THE summary of the statement of affairs at May 17th, 1893, the date of the winding up order, and the Official Receiver's observations thereon, have been issued. They form a voluminous document, which it is impossible for us to publish in full, and we can now only refer to the most important features.

The company was registered on July 12th, 1889, and formed for the primary purpose of amalgamating the businesses of five other companies, four of which were Woodhouse & Rawson companies of some form, and the fifth, C. L. Baker & Co., Limited. The prospectus stated that the profits of the business of Woodhouse & Rawson, Limited, for the year ending June 30th, 1888, were £21,440. The Official Receiver has examined into these profits, and discovered that a large portion arose by reason of the assumed value of various interests in other companies. He has not seen the accounts in the liquidation of Woodhouse & Rawson, Limited, and consequently has at present no means of informing himself precisely to what extent the said profits have been realised, but he believes it is the fact that a large portion of them was illusory. The expenses of promotion are stated to have amounted to about £10,000. The terms upon which the several original companies were acquired, and the methods of payment are set out in detail, together with the several items forming the totals and the valuations of the properties and the names of the valuers; £269,000 was the total amount, and of that £97,000 was goodwill and £85,500

was for patents. The first prospectus stated that 15,700 ordinary and preference shares had been applied for by the directors and their friends, but the Official Receiver has been unable to verify this statement, except as regards about 12,000 shares, from the company's records. The various issues of capital are recorded by the Official Receiver, and sundry extracts given from the prospectuses tending to show the very profitable and satisfactory nature of the business conducted. These various prospectuses are stated to have been drafted by Mr. F. L. Rawson, and settled by the board of directors. Since the company was formed further businesses have been acquired. These are stated in detail by the Official Receiver. The total purchase price was £41,500. They were paid for in cash to the amount of £15,929 10s., debentures £25,000, and shares £500.

On the formation of the company £75,000 was deposited by the vendors as guarantee for dividend, and, as our readers will remember, was subsequently surrendered. The Official Receiver states that the fund was "deposited" by leaving purchase-money to that extent unpaid, and the reserve appears amongst the assets in the accounts of 1890 against the dividend guarantee fund consisted in nearly equal amounts of shares in the English Elmore Company, and a loan at 6 per cent. from the company to Woodhouse and Rawson, Limited. The "gross income" in the same year's accounts included £37,235 in respect to the promotion of the International Okonite Company. The Official Receiver regards this profit as a very doubtful item, and says it will be a matter for further consideration: (1) Whether the directors were justified in treating certain of the profits as earned and divisable, instead of placing them to a suspense account, pending the development of affairs? (2) Whether Mr. F. L. Rawson was entitled to be credited with the full amount of 25 per cent. commission in respect of surplus profits, and (3) whether the facts were fully before the shareholders when they consented to part with the guarantee fund. In view of the company's subsequent history, the Official Receiver notes that although the dividend guarantee fund of £75,000 was lying in the business without interest, a portion of it (£50,722), under the arrangement made, became immediately chargeable with interest at 5½ per cent., under which circumstances a rebate of £12,000 made by the vendors has been at least a doubtful advantage. The "sundry investments," the arrangements with the Phœnix Trust Company, the recording of "assumed profits" on various promotions in the accounts of 1891, are all dealt with by the Official Receiver; but his enquiries are not complete. He says that the accounts for this year will also form the subject of further enquiry, particularly in connection with the question whether the directors were justified in declaring dividends out of profits which could only be estimated, and were in such a large degree unrealised. Notwithstanding the alleged prosperity of the company as described in the annual reports, it is the fact that about this time the directors found it necessary to have recourse to borrowing moneys for the purpose of carrying on the business. Some particulars of these loans are given.

The summary of the statement of affairs, as regards creditors, shows liabilities £14,713, and assets £44,349, leaving an estimated surplus of £29,636. As regards contributories, there are liabilities of £477,959, deducting from which the estimated surplus mentioned above leaves a total deficiency of £448,321. The total liability on debentures and debenture stock is £203,592, but it is subject to deductions amounting to £42,737, reducing the net amount of the liability to £160,854. The valuation of the assets, which shows a surplus over creditors, is not concurred in by the Receiver for Debenture-holders, and several officials express their views on this head. The Official Receiver has prepared the report for the purposes of the first meeting, and there are a number of matters into which he proposes to make further enquiry. The causes which have led to the insolvency of the company are given by the managing director, but we may close this brief summary with a verbatim quotation in the words of the Official Receiver: "It seems to be clear that the energies of the directors were devoted in a very large degree to the promotion of the companies that have been mentioned; apart entirely from the consideration of *ultra vires*, it is open to the question whether they were justified in so engaging themselves, having regard to the fact that the first prospectuses clearly contemplated the carrying on of an industrial, and not a financial business. As regards the payment of dividends, it is possible some claim may rest upon the directors for reimbursement."

NOTES.

Faure's Accumulator Patent in Germany.—The Imperial Court of Appeal at Leipsic has just decided in an action brought by the Hagen Accumulator Company against certain manufacturers of secondary batteries in Germany, that the employment of lead in the state of super-oxide, oxide, or insoluble salts as a filling material for accumulator plates comes under Faure's patent.

Bolton Electric Light Station.—The ceremony of laying the foundation stone of the Bolton Corporation Electricity Buildings, in Spa Road, was performed last week by Alderman John Miles, J.P. (chairman of the Gas, Electricity, and Street Lighting Committee), in the presence of a company of members of the Corporation and the officials, the proceedings being presided over by the Mayor. An accident occurred a few days after to the crane employed at the works; no one was injured.

The Worshipful Company of Clothworkers' Scholarship.—This valuable scholarship, entitling the holder to a five years' training at the City and Guilds Institute and the Central Institution of South Kensington, as well as to a sustentation allowance, has just been awarded to Ernest W. Cook, aged 13, of St. Thomas Charterhouse Boys' School—a school which has for nine successive years succeeded in carrying off this valuable prize. The subjects of examination were:—Physics, mathematics, mechanics, perspective, other art subjects, and also general English subjects.

Arc Light Carbons.—The *Elek. Techniker* describes an improvement, used by the firm of Krupp, in Essen, for the manufacture of carbons. The paste from which they are made is mixed with tungstic acid or tungstates; this increases the number of hours during which the carbons will last, in the ratio of 21 to 18, or by using slightly larger carbons, the time may be increased 28 per cent. It is claimed that the light-giving property is also increased, and that there is no wasteful dust. Abstracted in the New York *Electrical World* "Digest," November 11th.

The Telephone in Germany.—According to the *Zeitschrift für Electrotechnik*, the number of telephone stations in Germany, which was 1,504 in 1881, was 63,558 on June 1st, 1892, Berlin figuring in that number for 17,424 stations with a network of 32,669 kilometres of lines. The interurban telephone service is also rapidly spreading. At the beginning of 1892 there were 310 long-distance telephone installations with a total length of 22,849 kilometres, the longest being that between Berlin and Breslau, which is 352 kilometres in length.

The Employment of Electric Lighting Currents for Medical Purposes.—Mr. W. S. Hedley writes to the *British Medical Journal* on this subject as follows:—"As space prevents the insertion of a long letter, will you kindly permit me to make the following brief remarks:—1. That the statement that 'with an 8-candle lamp permanently fixed in the (100-volt electric light) circuit with the patient he cannot become the path of a current of a really dangerous magnitude,' seems to me to require material modification. 2. That the assertion that 'pain is greater with the 100-volt light circuit passed through a controlling R., than when supply is drawn from a battery of low voltage,' cannot, I think, be substantiated either in theory or in fact. 3. That for cautery purposes or lighting small lamps, accumulators are, in my opinion, the best method of utilising continuous current supply; but not the best as a fixed installation for ordinary medical purposes, when the supply in the mains is constant."

Cable Enterprise.—A telegram from New York on the 14th inst. contained the following paragraph:—"The Canadian Minister of Commerce, Mr. Mackenzie Bowell, on his way from Australia to Canadia, *viâ* Hawaii, on December 4th, made a timely and effective address to the Honolulu Chamber of Commerce. It was a private meeting, and reporters were excluded; but it is known that he proposed a treaty with Canada for the promotion of a line of steamers for laying down cables and encouraging trade. The Hawaiian Minister is reported to have said that if the United States repulses the overtures from the Provisional Government, negotiations will be opened with England."

Long Distance Transmission in America.—The General Electric Company, of America, have installed the first three-phase system of electric power long distance transmission at Redlands, Cal. The water-power employed for the generators has a fall of 353 feet, equal to a pressure of 160 lbs. per square inch, and a volume of delivery equal to 2,400 cubic feet of water per minute. Two Pelton water-wheels are used, of 400 horse-power, each coupled direct to the generators, which are driven at 600 revolutions per minute; the electric pressure is 2,500 volts. The periodicity is 100 per second, and the two dynamos are arranged to run in parallel. One circuit is 7½ miles long to Redlands, where the currents are transformed and used in a general distribution scheme; another circuit is 4½ miles to Mentone, where a 150-kilowatt synchronous three-phase motor is driven at 750 revolutions per minute, for operating ice-making machinery. In the towns of Redlands and Mentone arc and incandescent lamps are run off the three-wire circuits, and no troubles have been experienced from any unbalancing of the circuits. It is astonishing how little has been done commercially in America with the two-phase system, which was so much written up and introduced about five years ago. The Tesla system of motors seem to be entirely eclipsed by the later three-phase motors. The General Electric Company are rapidly developing the three-phase and single phase alternating motors for transmission of power from waterfalls.

Pacific Cable Conference.—The *Times* Auckland correspondent says:—"The New Zealand Ministry have decided not to send a representative to the proposed conference, which is to be held in Canada before the end of the present month, between delegates from the principal colonies of Australasia and the Dominion of Canada on the subject of the construction of a Pacific cable touching only British territory." From this it seems that New Zealand is at present satisfied with the reduction of rates effected under the guarantee agreement between the Australian colonies and the Eastern Extension Telegraph Company, to which New Zealand became a party about a year ago, under the condition that the Australian colonies should bear a certain proportion of the loss which New Zealand would suffer through the reduction of rates on the New Zealand-Australian cables. The decrease in the cost of cable messages between Australia and New Zealand has, according to the Hon. J. G. Ward, Postmaster-General of New Zealand, been heavy. Mr. Ward has also stated that he did not object to the Eastern Extension Company becoming "a huge monopoly" as long as the business was conducted satisfactorily. It appears that the heavy decrease on cost of messages has been followed by a traffic increase of nearly 85 per cent. on the inter-colonial messages, which points either to a heavy guarantee for the colonies, or to a considerable drop in the profits on the two inter-colonial cables; possibly both parties might suffer. However, the Eastern Extension Company are well able to stand a reduction in profits, if one may judge from the excessive prices they could afford to pay for their cables. The contract price for the first of these two cables being officially given as £300 per mile, or about double the cost at which such a cable could have been obtained in the open market. If the telegram above quoted be correct, it is to be regretted that Mr. Ward should content himself with the advantages gained by his predecessors, and fails to recognise that this question is not altogether an affair of reduced rates, however important such a reduction may be, but affects the security and continuity of communication between Great Britain and her colonies, under all circumstances.

The Brussels Electric Tramways.—In the course of an article on the above subject, *Le Mouvement Economique* says that there are three distinct lines belonging to two different companies in course of construction. The central station of the Société Anonyme les Tramways Bruxelles is in the Rue Brogniez, the present installation (provision having been made for enlargement) being composed of five steam engines, five dynamos of 500 kilowatts each, the boilers being of the Babcock and Wilcox type. The central station of the third line (belonging to the Société des Chemins de Fer Viciniaux) will be situate in the Rue d'Instruction, and will contain two 500 horse-power engines working two 500 kilowatt dynamos, and Babcock & Wilcox generators. The generating dynamos are on the same plan as those of the central station for the electric lighting of Brussels.

Standard of Light.—M. Blondel, in *La Lumière Electrique*, November 4th, discusses the references made to standards of light by Dr. Thompson, at the Congress of Chicago. He states that Captain Abrey was really the first to suggest the use of a known surface of the crater of an arc as a standard of light. Further he says that the figure given by Dr. Thompson is about 100 per cent. too low; also that he, Blondel, only proposed to use the arc as a secondary standard in connection with the Violle standard. He claims that there ought to be two standards in practice, one of a yellow tint such as the Violle, and the other a white light such as the arc, and that the two should be compared with each other accurately once for all; the Carcel or Hefner lamp being used if the Violle standard is not practicable. The article is "Digested" in the New York *Electrical World* for November 25th.

Re a Successful Combination of Storage Batteries with the "Trolley."—In a recent issue of the New York *Electrical Engineer*, Dr. Paul Schoop has an article on this subject. No doubt the arrangement as described therein, and consisting in using storage batteries as an auxiliary at the station itself, will be found of advantage in many cases. The question whether this arrangement should be preferred to placing the accumulators in the cars themselves will greatly depend on local circumstances and the length and insulation of the line. It must, of course, not be lost sight of that the losses arising from the resistance of the line or leakage apply both to the generating dynamos and the accumulators placed in the station; while with self-contained cars the efficiency only of the accumulators need be taken into account. The price of the battery ($4,000), which is reported to consist of 270 cells, each of a capacity of from 140 to 150 ampère-hours, seems rather high compared with the prices paid in this country, where a battery consisting of 270 cells of an improved Planté type can be obtained for about $2,300, such battery not acting only as a regulator, but having the same capacity as the above, viz., about 150 ampère-hours.

The Queensland Telegraph Department.—The report of the Post and Telegraph Department of Queensland for the year 1892 states that there are now 10,002¾ miles of line, and 17,801¾ miles of wire open for public business. Since the last report 161½ miles of wire have been erected. At the close of 1892 there were 354 stations in daily operation, and 754 officers employed, including those holding appointments in other departments, but exclusive of assistants at country stations (officers' wives) and construction parties. With the exception of the great inconvenience caused by the disastrous floods of February, the lines throughout the Colony have worked very well during the past year. The interruptions do not appear to have been unusually numerous, or of a more varied or extensive character than those referred to in recent annual reports. The causes set down are also very similar, viz., timber blown on lines, poles down, broken insulators and pins, brackets off, crosses, storms, lightning, bush fires, line parties at work, large birds flying against wires, lines dragged down by teamsters and others, office faults, &c. 88 interruptions, due to floods, were recorded in the southern and western districts. The expenditure on maintenance and repairs for 1892 was as follows:—Southern district, £4,824 4s. 11d.; central district, £1,369 7s. 11d.; northern district, £3,656 4s. 9d.; total, £9,849 17s. 7d.

Chapel Electric Lighting.—The Hall and principal rooms at George Street Free Methodist Chapel, at Burton-on-Trent, are to be lighted by electricity.

Kingswood Electric Lighting.—Members of the Local Board complained of the inferior lighting of the district. The only reply forthcoming was "the current is at fault"!!

Richmond Chimney Shaft Unsafe.—We hear that the chimney shaft at Richmond electric lighting station was seriously affected by the wind last week, and it is said to be in a very dangerous condition.

Errata.—In last week's issue, page 638, second column, line 7, for "if they are at rest, &c.," read "if any are at rest, &c.;" and on page 640, first column, line 15, for "mathematical affinity," read "mathematical infinity."

Lectures.—Mr. C. E. Frank delivered a popular lecture in the large hall of the Young Men's Christian Association, Bristol, last week, on "Electricity: Our New Public Servant."

A very interesting lecture was given the other day in the Beckwith Street Schoolroom, Birkenhead, on "The Power of the Electric Motor in reference to Railways in the Future," by Mr. Charles Retter.

The other day, at the St. George's Hall, Llandudno, under the auspices of the Literary and Scientific Society, a lecture on "Electricity in Motion," was delivered by Mr. William Kingsland, A.I.E.E.

Fitzgerald's Improved Lithanode and Spongy-Lead Plates.—Without wishing to detract from the merits of the improved lithanode plates, it ought, in justice to makers of other types, to be said that the great difficulty hinted at as existing in all other lead accumulators is, to our knowledge, at least in one cell on an improved Planté type, conspicuous by its absence. We are alluding to the alleged local action which, according to the author of a paper which appeared in the *Electrical Engineer*, is set up by the contact of the peroxide with an oxidisable metal, by which is meant the metallic part of the plate. If such detrimental effect were invariably produced, how would it be possible for an accumulator of a certain type to retain 80 per cent. of its charge during a rest of three months?

The New Dictionary.—Some months ago we published an advance note regarding the new standard dictionary of the English language, which is being brought out so enterprisingly by Messrs. Funk & Wagnall's Company, of New York. The first volume of this gigantic work, the extensive proportions of which we have previously commented upon, was to be published on December 16th, after four years' arduous labour had been expended upon its compilation. Advance orders numbering tens of thousands have been placed with the publishers. From the prospectuses and various pamphlets which have come before us, it seems that the dictionary will be the most complete ever published, and it is the aim of Messrs. Funk & Wagnall that such should be the case; but we shall be better able to speak with absolute certainty when the dictionary comes to hand.

Cable Communications.—The following is a list of recent cable interruptions and repairs:—

Name of cable.	Date interrupted.	Date repaired.
Brest-St. Pierre (Anglo Company) ..	April 6th	...
Shanghai-Amoy	Sept. 26th	...
Paramarito-Cayenne	Oct. 25th	...
Bissao-Bulama	Nov. 24th	...
Jamaica-Colon	Nov. 25th	...
Cayenne-Vizeu	Nov. 25th	...
San Domingo-Martinique	Dec. 10th	...
Singapore-Saigon	Dec. 11th	Dec. 15th
Hong Kong-Haiphong	Dec. 11th	...
Moulmein-Bangkok (land-line)	Dec. 14th	Dec. 18th
Bonny-Cameroons	Dec. 18th	...

The Electric Light on Board a Troopship.—The Admiralty have ordered a new set of electric lighting machinery for H.M. troopship *Himalaya*. The work of fitting the new gear will be taken in hand when the vessel returns to Devonport from her trip to China.

The Electric Lighting of Omnibuses.—The electric lighting of omnibuses has lately come in for a good deal of abuse in the daily press. From our own knowledge we can safely say that any defects in lighting that may have occurred are due to the action of the omnibus company, and that the suppliers of the batteries are in no way responsible for the failures.

On the Evolution of Gas during the Charging of Accumulators.—From the electro-chemical equivalents of hydrogen and oxygen, it appears that the 216 cubic centimetres of gas evolved in the charge of No. 1 cell corresponds to ·345 ampère hours, or at a charging current of ·5 ampère to 41·4 minutes charging work. It would be interesting to learn whether the rapid rise in the counter E.M.F. of that cell coincides with the gasing. The loss in cell No. 2 (in which, according to the author of an article in a London contemporary, local action took place), occasioned by the electrolysis of the liquid, amounts to 2·03 ampère hours, or in other words at the charging rate of ·5 ampère, a little over 4 hours' charging work was consumed by such electrolysis. The importance of using pure acid and pure water for the electrolyte in an accumulator should never be neglected.

Non-electrolytic Dissociation.—A contribution to the dissociation hypotheses has been made by M. Wildermaun, who regards two kinds of dissociation as possible, namely, electrolytic dissociation into ions, and non-electrolytic dissociation into larger molecular aggregates of the dissolved substance into smaller aggregates. This new assumption, which is elaborated in the *Berichte*, xxvi., pp. 1,773—86, appears to be of use, in so far as it is sufficient to explain the divergencies and discrepancies existing between the observed data and the numerical values calculated on the electrolytic dissociation hypothesis alone. Wildermaun also discusses, in this paper, the electrical conductivity of salt solutions which do not in general obey the dilution law applicable to weak acids and bases. He then discusses the matter mathematically, and deduces formulæ which show a qualitative agreement with the experimental data; but these must be accepted with reserve, since the mathemathics appear to be imperfect, and to be largely based on this new assumption of non-electrolytic dissociation.

Some Researches on Dissociation.—That the molecules of compounds like the common salts dissociate when dissolved in water has been shown by such independent lines of evidence that it can no longer be reasonably doubted. It has also been found that alkalies, acids, and many other compounds conduct themselves in a similar manner. The qualitative fact being established, it is of interest and importance to determine the amount of dissociation which compounds undergo when different quantities are dissolved in water. This has recently been done for a large number of substances by Dr. Harry C. Jones, who made use of the "freezing point method" as improved by Beckmann. The *Philosophical Magazine* for December contains many pages of results obtained in this research, and it is interesting to note that, in the main, they exhibit a remarkable agreement with those obtained by Kohlrausch by means of the "electrical conductivity method" (*Wied. Ann.*, xxvi., page 160). The paper will be of special interest to Mr. S. N. Pickering, and other doughty opponents of the dissociation theory, who will find it necessary to make a rejoinder if they are to maintain the position they have taken up. Besides investigating the dissociation of inorganic electrolytes, Dr. Jones included a study of the behaviour of a number of organic compounds which do not undergo electrolytic dissociation, and some important conclusions may be anticipated when this field of research has been more fully explored on the same lines. The experimental work was done in Prof. Ostwald's laboratory at Leipzig.

The Colour and Speed of the Ions.—Last year W. Ostwald investigated the absorption spectra of solutions of various coloured salts, and came to the conclusion that the spectra of dilute solutions of salts with the same coloured ion are identical. It appeared from his observations (*vide Zeit. Physikal Chem.*, ix., p. 579) that the absorption depended on the colour of the ions in the solution, and not on that of the dissociated molecules of the dissolved salt. These conclusions are, however, contested by G. Magnanini in a recent paper (*vide Zeit. Physikal Chem.*, xii., p. 56), in which he shows that the salts of violuric acid give red aqueous solutions, whilst violuric acid itself gives colourless solutions, although it is dissociated to the extent of 8 per cent. at a dilution of 256. It cannot, therefore, be the negative ion which causes the absorption in the salt solution, nor can it be the positive metallic ion; so that the colour must come from the undissociated part. In Wiedemann's *Annalen der Physik und Chemie*, No. xi., 1893, there is a useful paper, by F. Kohlrausch, on the speed of electrolytic ions, which consists of a compilation of tables of absolute velocities, of mobilities, and of coefficients of electrolytic friction according to the latest and most reliable data.

Saladin's Electric Furnace.—A paper has been read by Mons. Saladin, before the Chemical Society of Paris, on his improved electrical furnace. This furnace appears to differ in principle from others, as it is based upon the electrical cautery. A platinum spiral rendered incandescent by means of a continuous or alternating current of electricity is placed in a vessel of refractory material, and the whole is enclosed in a cast-steel case. It is possible to act upon substances placed in this furnace by means of high pressure, as well as high temperature. A side opening in the case communicates with a pump and manometer, and admits of the pressure being increased to 1,000 atmospheres. The range of temperature available is 1,500°—1,800° C., and this is measured by a platinum-rhodium couple, arranged according to Le Chatelier. Mons. Saladin claims that by means of this furnace it becomes possible to fuse metals under high pressure, and whilst maintaining any desired pressure to cool the molten metal as slowly as is deemed desirable, this cooling being governed by regulating the current. At present we understand that this furnace is being used in obtaining experimentally the reproduction of minerals from elementary matters, the idea being to imitate the probable conditions under which they have been naturally formed. There ought, however, to be a wider and more directly useful field in which this furnace might be employed. The original paper by Mons. Saladin may be found in the *Bulletin* de la Société Chemique de Paris [3], Vol. ix., No. 5, pp. 133—136.

Some Electrical Researches on Organic Compounds.—The electrolytic decomposition of certain organic acids is now engaging the attention of several scientists. The most recent contribution to our knowledge of this department is from N. A. Bunge. He electrolysed a solution of monochloracetic acid in a cell divided into two compartments by means of a membrane of parchment paper. The positive electrode was a platinum plate dipping into the solution in one compartment, the negative electrode being mercury, which was covered with mercuric oxide and a solution of bicarbonate of soda in the other compartment. It was found that the gas arising from the positive electrode consisted entirely of chloric and carbonic acid. When an alkali was substituted for the free acid, no chlorine was evolved. Similar results were obtained with trichloracetic acid. Oxygen and traces of carbonic acid were evolved by the electrolytic decomposition of sodium ortho-chlorobenzoate, and there was no indication either of chlorine or of chloride in the electrolysed solution. Potassium meta-nitro-benzoate behaved similarly. S. P. Mulliken, whose work on the lines of Crum Brown and Walker we have already noticed in the ELECTRICAL REVIEW for November 17th, has been engaged in making more organic electro-syntheses. These may be described as converse in character to the operations carried out by Bunge. His recent work has dealt with the ketonic derivatives. The products obtained by the electrolysis of such compounds appear to be formed by the combination of the anions, so that they are identical with products which are obtained by treating the silver or sodium derivatives of the same compounds with iodine.

NEW COMPANIES REGISTERED.

Calthrop Bros., Limited (40,083).—This company was registered on the 9th inst., with a capital of £10,000 in £10 shares, to carry on in the United Kingdom the business of manufacturers of, and dealers in, cake, and other feeding stuffs, the oils, soaps, scents, essences, manures, and all like products; and also the business of electrical engineers, suppliers of electricity, light, heat, and motive power. The subscribers (with one share each) are:—E. R. Calthrop, Freshfield, Lancashire, civil engineer; J. Mary Calthrop, Freshfield, Lancashire, married woman; Amy Calthrop, Formby, Lancashire, married woman; F. A. Rockliff, Castle Street, Liverpool, stationer; R. E. Webster, 2, Pump Court, E.C.; Knight, Q.C., M.P.; H. C. Calthrop, 133, Shooter's Hill Road, Blackheath, gentleman. Messrs. Richard Calthrop and F. C. Calthrop have been nominated as the first directors of the company; the qualification and remuneration are to be determined from time to time in general meeting. Registered by T. T. Hull, 22, Chancery Lane, W.C.

Universal Electric Lighting Company, Limited (40,068).—This company was registered on the 7th inst. with a capital of £5,000 in 10s. shares; to generate, produce, store, accumulate, and distribute electricity, electromotive force, or other similar agency, for the purpose of lighting omnibuses and other vehicles, and public or private buildings. The subscribers (with one share each) are: Jas. F. Rogers, 105, Penton Place, S.E., clerk; C. F. Croll, 8, St. Agnes Place, S.E., clerk; H. Gibbs, 65, Glyn Road, N.E., clerk; G. F. Wenborn, Tonbridge, Kent, clerk; W. J. Griffiths, 40, Albert Road, N., clerk; A. H. Clayson, 27, Borthwick Road, E., clerk; R. B. Webster, 3, Kendal Villas, S.E., clerk. Registered office, 18, Eldon Street, Finsbury, E.C.

Acme and Immisch Electric Works, Limited (40,125).—This company was registered on the 16th inst. with a capital of £25,000, in £1 shares, to carry on the business of electrical and mechanical engineers, electricians, and as manufacturers of and dealers in machinery, materials, stores, appliances, and apparatus of every description applicable for in connection with the supply or use of electricity or magnetism for any purpose, and also to acquire the undertaking and assets of the Acme Works, Chalk Farm, and of the General Electric Power and Traction Company, Limited, at Kentish Town. The subscribers (with 10 shares each) are:—H. C. Mance, K.B., Manora, Newhorn Road, Bedford; U. Immisch, 48, Tollington Park, electrical engineer; Wm. Bulloch, Queen Street Chambers, E.C., chartered accountant; J. Gray, Queen Street Chambers, E.C., secretary; E. Garcke, Queen Street Chambers, E.C., director; Thomas Smith, 46, South Hill Park, N.W., accountant; J. Renwick, 58, Olinda Road, N., clerk. There are not to be more than four directors. Qualification, £50. Remuneration, £100 per annum. Registered office, Queen Street Chambers, Queen Street, Cheapside, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Aurora Electric Lighting and Distribution Company, Limited.—This company has lately filed its annual return, which shows that out of a capital of £25,000, in £1 shares, 5,935 shares have been taken up. The full amount has been paid on 935 of these, and £5,000 has been considered as paid on the remaining 5,000.

Halifax Mutual Electric Light and Power Company, Limited.—It has been resolved that this company be wound up voluntarily under the provisions of the Companies' Acts, 1862 to 1890. Mr. W. D. Taylor, of Halifax, Yorkshire, has been appointed liquidator.

Manchester Electricity Supply Company, Limited.—This company has been dissolved, by notice in the *London Gazette*, under clause 7 of the Companies' Act, 1880.

J. C. Howell, Limited.—On November 27th last this undertaking filed its yearly return, which states that out of a nominal capital of £25,000, in £5 shares, 2,907 shares have been taken up, and £5 has been called on each of 907 of these. The other 2,000 shares have been agreed to be considered as paid. A sum of £4,510 has been remitted, and there is £25 in arrear.

Aladdin Primary Electric Battery Company, Limited.—The statutory return of this concern shows that the nominal capital was £6,000 in £10 shares; that all these have been taken up; that £5 has been paid on 160 of them; and that £800 has been remitted. There has been £4,400 agreed to be considered as paid.

Lancashire and Yorkshire Electric Lighting Company, Limited.—The last return of this undertaking shows that, out of a nominal capital of £100,000, in £5 shares, 127 shares, with £2 10s. called on each, have been taken up. There has been £315 remitted in answer to calls, and £2 10s. is outstanding.

Laurence, Scott & Co., Limited.—This company, which was formerly known by the name of Laurence, Paris & Scott, Limited, has filed its yearly return, which bears the date of November 3rd last. Out of a capital of £30,000, in £10 shares, 1,406 shares have been taken up, and £10 has been called on 906 of these. The total amount received is £9,060, and £5,000 has been agreed to be considered as paid on 500 shares.

Laws' Electrical Appliances Company, Limited.—This company has been wound up voluntarily, and from a notice signed by the liquidator, Mr. E. F. Law, and filed at Somerset House on September 25th last, it appears that the winding up has been concluded satisfactorily.

Liverpool House-to-House Electricity Company, Limited.—The last return of this company shows that out of a nominal capital of £100,000, in 19,900 ordinary and 100 founders' shares of £5 each, 107 shares only have been taken up. Nothing has been called, but £500 has been agreed to be considered as paid on the 100 founders' shares.

Lineff Electric Traction and Lighting Syndicate, Limited.—The annual return of this company, made up to the 30th ult., shows that out of a nominal capital of £15,000, in £1 shares, 11,431 shares have been taken up, and that the full amount has been paid on 3,428 of them. A sum of £3,428 has been remitted; and £8,003 has been agreed to be considered as paid.

Loughborough Electricity Supply Company, Limited.—This company has been dissolved under clause 7 (4) of the Companies' Act, 1880, 43 Vict. Ch. 19, by notice in the *London Gazette*, dated August 15th, 1893.

London Rubber and Packing Company, Limited.—The last annual return of this company shows that, out of a nominal capital of £3,000, in 15 founders' and 585 ordinary shares, all of £5 each, the whole of the founders' and 245 of the ordinary shares have been taken up. The full amount has been paid on the former class, £5 on 10 ordinary, and £2 10s. on each of 205 ordinary shares. The total amount received is £592 0s. 1d. £150 has been considered as paid, and £45 9s. 11d. is still outstanding.

Mather & Platt, Limited.—On November 15th, 1893, this company filed its yearly return. It shows that the nominal capital is £200,000, in £10 shares, and that 15,000 shares have been taken up, with £9 paid on each. The total amount of calls received is £135,000.

South-Western District and Thames Valley Electricity Supply Company, Limited.—The annual return of this company, made up to a month or so ago, shows that out of a nominal capital of £100,000, in £10 shares, only the seven subscribers' shares have been taken up; these have been paid in full.

Monte Video Telephone Company, Limited.—This company has filed its annual return, which is dated November 21st, 1893, and which shows that out of a nominal capital of £220,000, in 29,000 preference and 15,000 ordinary shares, all of £5 each, 28,000 of the former and the whole of the latter have been taken up, and the full amount called on each. The total sum received on this account is £185,000, and £30,000 has been agreed to be considered as paid.

Electrical Coal-Cutting Contract Corporation, Limited.—The ordinary yearly return of this company was filed on the 11th of last month. It states that the nominal capital is £402,000, in 60,000 £5 ordinary, 20,000 £5 deferred, and 2,000 £1 founders' shares, out of which 9,531 ordinary, 20,000 deferred, and 2,000 founders' have been taken up. The full sum has been called on 4,082 ordinary, £3 15s. on 1,449 ordinary, and £1 on the 2,000 founders' shares. The amounts received reach £26,563 15s.; the figure considered as paid on 4,000 ordinary and 20,000 deferred shares equals £120,000, and there is £1,280 yet outstanding.

Morecambe Electric Light and Power Company, Limited.—The last return of this company shows that out of a capital of £15,000 in 14,950 ordinary and 50 founders' shares of £1 each, that the whole of the latter and 3,836 of the former have been taken up. Sums of £1 has been paid upon the founders', 16s. upon 2,985 of the ordinary, and £1 upon each of the remaining 851 ordinary shares. The total amount received reaches £2,350 10s.; £851 has been considered as paid; £361 5s. is outstanding, and £11 15s. has been paid on two founders' 116 ordinary forfeited shares.

MacMahon's Patent Electric Check System, Limited.—This company has been wound up, and the property of the company duly disposed of.

Putney and Hammersmith Electric Light and Power Supply, Limited.—Mr. V. B. D. Cooper, in writing to the Registrar of Joint Stock Companies, says, "That the entire undertakings of the company have been abandoned."

Maudslay, Sons & Field, Limited.—The last yearly return of this company shows that out of a capital of £350,000, in 25,000 ordinary and 10,000 6 per cent. preference shares, all of £10 each, that every share has been taken up. A sum of £10 has been called on each of the preference shares, and £250,000 has been considered as paid on the other class.

Ozone Syndicate, Limited.—This company has filed its return for 1893, which shows that out of a capital of £25,000, in £5 shares, only the seven subscribers' shares have been taken up. No call has yet been made.

Peru Telephone Company, Limited.—The last annual return of this undertaking shows that out of a capital of £100,000, in £5 shares, merely the seven subscribers' shares have been taken up. Nothing has been called or paid.

Maquay Syndicate, Limited.—This company has been wound up, and at a meeting held on the 18th of last month, it was shown how the liquidation had been conducted, and the property of the company disposed of.

London Carbons Manufacturing Company, Limited.—This undertaking has been dissolved, by a notice in the *London Gazette*, under clause 7 of the Companies' Act, 1880.

Ipswich Electricity Supply Company, Limited.—The registered office of this company is now at the Acme Electric Works, Ferdinand Street, Chalk Farm, N.W.

CONTRACTS OPEN.

Brighton.—December 23rd. For the supply and delivery of about 500 tons of steel rails and fishplates, and for the supply and delivery of about 400 tons of Portland cement, for the Brighton and Rottingdean Seashore Electric Tramroad Company. Specifications and conditions can be obtained from Mr. R. St. George Moore, A.M.I.C.E., of 17, Victoria Street, Westminster, or Mr. Magnus Volk, M.I.E.E., Madeira Road, Brighton, on payment of 5s. Tenders must be sent to Mr. Magnus Volk, acting secretary, 58, Ship Street, Brighton, by 23rd inst.

Barnsley.—For lighting the Barnsley Arcade and adjoining property by electricity, for the Barnsley Arcade Company, Limited. Application to be made to Messrs. Wade & Turner, 10, Pitt Street, Barnsley.

Leeds.—For fixing the various fittings requisite in electric lighting inside and out Wren's Hotel, New Briggate. Application for particulars to be made to Mr. J. Townsend.

Wolverhampton.—The Lighting Committee of the Corporation want tenders for the erection of an electric lighting station in Commercial Road, in that borough. Plans and specifications may be seen at Mr. Brevitt's, Devonshire Chambers, Wolverhampton.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's).—The above directory is now in the press, and all insertions, corrections, and advertisements for the 1894 issue, should be forwarded at once to H. Alabaster, Gatehouse & Co., 22, Paternoster Row, London.

Harrogate Electric Lighting.—The electric lighting scheme for the Borough of Harrogate, projected by Mr. George Wilkinson, M.I.E.E., consulting engineer, and recently adopted by the corporation of Harrogate, is intended, first, to produce and supply the electric light at a cheap rate, so as to compete with the existing gas supply, which is in the hands of a limited company; and, secondly, to deal in an effectual way with the refuse collected from the ash pits of the borough. The results of exhaustive experiments made by Mr. Wilkinson on an extensive scale demonstrate the fact that what is known as "town's refuse," when put through a process of sorting, sifting, and drying, has a well defined value as a fuel for generating steam power. The method hitherto adopted in many towns, of placing the crude wet unsorted material into immense brick kilns or furnaces, where it roasts for a time and smoulders, has been found quite unsuited for steam power generation. The capital cost for such "dust destructors" is heavy, the combustion obtained owing to the presence of a large amount of moisture and incombustible matter is but feeble, and, as a consequence, the gases evolved are deleterious to health. These prime defects have led to a general concensus of opinion that the game of generating steam for electric lighting purposes by this means is not "worth the candle." The system resorted to by Mr. Wilkinson is entirely novel, and is a departure from all the methods of "dust destruction" hitherto adopted, and the correct term for this plant would appear to be "refuse utiliser." The process in outline is as follows:—The refuse is brought in carts or otherwise, and tipped upon a platform, whence it is automatically carried into a rough-sifting apparatus, which separates the old pots, cans, &c., the smaller material passing through the sifter and into a large hopper, from which it is forced in regular quantities into a drying cylinder, which extracts nearly one-third of its weight in the form of moisture. It then passes on to another sifter, which takes out the fine dust, the resultant fuel being passed down a shoot and automatically injected into the special boiler furnaces. The dust forms a valuable manure. We may also state that the metal separated from the refuse is reduced to copperas by a simple process; and the rags are available for paper manufacture. Doubtless the outcome of Mr. George Wilkinson's scheme at Harrogate will be anticipated with general interest.

Woking and Electric Lighting.—The Sanitary Committee submitted to the Local Board the other day the estimates they had obtained from the gas and electric lighting companies. The electric lighting company offered to supply 34 lamps, each of 25 C.P., and 13 2-light fittings for 26 lamps, each of 25 C.P., on the following conditions:—Supplying and erecting 34 cast-iron columns with globes, lamps, and all fittings complete, and 13 columns with 2-light fittings complete, £314 10s., the interest to be charged on the outlay to be at the rate of 5 per cent. per annum up to the time of purchase; for maintenance, supplying current, lighting, keeping in repair, and renewing lamps at £4 8s. per lamp per annum, £264. The lamps to burn from sunset to midnight—2,000 hours. The gas company offered to supply and fix 100 street lamps for £400, providing they were fixed where mains were existing, the Local Board to pay interest at the rate of 5 per cent. on the outlay per annum. The company would undertake to keep them alight from sunset to midnight, with the exception of nights of the full moon in each month, and the two nights before and after full moon, for the sum of £2 18s. per lamp per annum; the duration of the contract to be for three years, with six months' notice, and on the termination of the contract the initial outlay to be repaid to the company, less 2½ per cent. for depreciation per annum. The Sanitary Committee reported that public lighting by gas would cost £310, including £20 for interest, annually, and by electricity £295 14s., including £14 15s. for interest; whilst the initial outlay for gas would be £400, as compared with £314 10s. for the electric light. Mr. Storey explained that the committee came to the decision that the gas lamps should be 75 yards apart and electric light 200 yards apart. Having obtained the estimates from the companies, the committee preferred that the Board should select which light should be adopted. He thought a decision should be arrived at without delay. The board resolved to adopt the electric light tender.

Yarmouth Electric Lighting.—The Electric Lighting Committee of the Town Council have submitted a report, stating that the Board of Trade had approved the proposed method of lighting, and that the Local Government Board had both sanctioned a loan of £15,000 for carrying out the scheme, and also approved of the site for the electric lighting station. The committee recommended the council to instruct Mr. Preece to prepare the necessary specifications, and also approved of the borough surveyor's plans for the proposed station. The report was adopted by the council without discussion.

Factory Lighting.—The London and Lancashire Electric and General Engineering Company, Limited, have recently completed the overhaul of the main engines and machinery at the Bulbourne Works of the Grand Junction Canal Company. Extensive alterations and additions to plant have also been made, which include a complete system of electric lighting for the whole of the works, for which purpose it has been necessary to provide extra boiler power. To meet this want, the London and Lancashire Company have put down a Davey-Paxman boiler of the Lancashire type, 18 feet × 6 feet 6 inches, which, besides supplying steam for the main engine, is of ample power to work a 6 H.P. nominal vertical slow speed engine belt-coupled to one of the firm's new overtype shunt wound dynamos, which can be utilised for accumulator charging purposes, or driving the lights direct. The wiring has been installed on the new watertight system, devised by Mr. C. N. Russell, the company's engineer, and as recently fitted by this firm at the Frogmore Mill, Hemel Hempstead. A model electric light installation has just been finished at "The Larches," Luton, the private residence of J. H. Green, Esq. The plant consists of a 3 H.P. nominal "Otto" gas engine, shunt wound dynamo, and "Epstein" cells. The total number of incandescent lights is about 60, and the engine house is about 50 yards from the main building, the lead covered main conductors being conveyed underground across the lawn. The official trial of the plant (which passed off without a hitch) took place on Wednesday last week. Mr. Albion T. Snell was the consulting engineer for the work. The firm have also been entrusted with the lighting of Lieut.-Colonel Martin's new residence, Petersham Terrace, Gloucester Road; Messrs. Wright, Layman & Umney's premises, Southwark Street; and a special plant for organ blowing by electricity.

Llandrindod Wells Electric Lighting.—At the last meeting of the Local Board, the clerk presented a full report from Messrs. Andrews and Preece, of Bradford, as to the proposal to light the district with electricity. They gave particulars of two schemes, viz., to provide 1,000 and 2,000 lamps of 8 candle-power respectively. The installation of the former number would cost about £3,000, and the annual cost (including repayment of loan and depreciation of plant) would be about £450, while the revenue, at 10s. per lamp, would be £500. The 2,000 candle-power plant could be established for about £4,000, and the annual cost would be from £500 to £600 a year. The revenue would be £1,000. The estimate was based upon the current being sold at "9d. per Board of Trade unit." Considerable discussion followed, and a general feeling was expressed in favour of the Local Board establishing the system rather than letting it to a company. It was also felt desirable to call a public meeting to take the opinion of the inhabitants upon the subject; but as the scheme was not yet complete, the clerk was directed to obtain further information on some points against the next meeting.

Mill Lighting.—Messrs. Martin Sons & Co. have lately adopted electric lighting at their Wellington Mills, Lindly. The contract was let to Messrs. J. H. Holmes & Co. A special dynamo room has been constructed, 48 feet long and 24 feet wide. At present there is only one large dynamo in it, but there is space enough for two, and in course of time another one may be laid down, in addition to an existing smaller one, which will be used alone for the lighting of the offices, independently of the main supply. The principal dynamo has a capacity for supplying 1,500 lights, but the present scheme only embraces 1,200 lights. It is driven by ropes from a counter shaft, on which is one of Bagshawe's (Batley) friction clutches, and it attains a speed of 430 revolutions per minute. In the weaving shed were 200 incandescent lamps, in addition to the ordinary gas.

Lighting of Electric Avenue.—The Electric Avenue at Brixton is again specially illuminated (from Monday 18th to the 23rd inst.) with over 60 Fyfe-Main arc lamps of 2,000 nominal candle-power each; also 1,200 fairy lamps interspersed amongst 100 full-sized trees. Between the columns, to the entire length of the colonnade, will be suspended baskets of foliage lighted by incandescence lamps. In addition to which there will be, across the road, a large number of foliated festoons brilliantly lighted with electric lamps. The illuminations, it is said, will surpass in brilliancy and artistic effect those of last year. The illuminating and decorative arrangements were designed by Mr. A. L. Fyfe, of the Fyfe-Main Electric Lighting and Contraction Company.

Trades and Industrial Exhibition in Bradford.—Electricity is, we hear, well to the front at this exhibition. Messrs. Roslin & Matthews, of Bradford, besides exhibiting a stand of incandescent gas lamps and electric appliances, have lighted the exhibition by means of 12 arc lamps of 2,000 candle-power each. The Wray Electrical Engineering Company, Bradford, show electric cooking apparatus, including an oven which can be heated by a 60-volt circuit, and lamps and electroliers, which are lighted up at night with no fewer than 100 lights, and make the corner of the hall occupied by their stand brilliant. Mr. Samuel Clayton, of Bradford, exhibits a number of gas engines, one of which supplies the power for the generation of electricity for the Wray Electrical Engineering Company's exhibit.

Electric Light at Aberystwyth.—It has been decided to grant to the Bourne and Grant Electricity Supply Company permission to lay their electric lighting mains along the main road from Capel Bangor to Aberystwyth, subject to the work being done as directed by the county surveyor, and to the deposit by the company of £50 with the county treasurer to cover any cost they may incur in restoring the surface of the road, and making good any damage done in carrying out the work, and subject, also, to an annual payment of 5s. for easement. It is anticipated that before the next summer season the greater part of the town of Aberystwyth will be lighted by electricity.

The "British Association" Screw Plate.—A few weeks ago we referred to a list we had received of the "lightning" pattern B.A. screw plate. We give below an illustration of the apparatus, which is made by Messrs. Selig, Sonnethal & Co. The cup-headed screw holds the halves together as a pivot, while the size is regulated by the wedge-shaped screw, the die being clamped in the elastic stock. The screws cut with it are said to be far more perfect than can be made with ordinary dies, and equal to the best lathe work, being neatly and sharply cut in the screws and nuts instead of being jammed out of the metal. No burr is raised above the true size. The work threaded with it need not be matched and kept together—they always correspond. The dies having all the strength and reliability of the solid die, are not solid, but are adjustable for wear so as to keep the exact size of the taps, notwithstanding long use, and to allow of nuts and screws for different purposes being made to fit together tightly or loosely as desired. When used up they can be replaced, the stock, &c., remaining good. The dies have guides for starting bolts true, but when desirable to cut close under the heads of bolts, the face side of the die is used. In a testimonial received from a firm of electrical engineers, it is stated to be "accurate both as to diameter of the different sizes of screws, and the pitch and shape of the threads. "The form of the dies being such as suits a receptacle of a circular form, enables them to be used very conveniently as dies for turret head screw-making machines and similar work."

General Electric Company.—Under the title of "Electricity," the General Electric Company have just issued a quarto volume of nearly 500 pages, forming a most complete and useful guide to the purchase of everything electrical. With the view, we presume, of rendering its use unobjectionable by all in the trade, there is an entire absence of the name of the company, and the handsome red cover affords ample room for the prominent display of the name of any firm who may use the book as their own catalogue. The contents are arranged under the following sectional headings:—Electric Light Supplies, Plant, Fixtures, Cooking, Bells, Telephones, and Medical, the edges of the leaves being labelled, so that any subject can be referred to without the delay of turning to the index. The work is not a mere trade list, but contains instructions on a great variety of operations, such as the wiring of houses for light, telephone, bells, and fire alarms; the choice of plant for electric light installations; the working of a dynamo (by Mr. W. C. Mountain); estimating for complete plants; electric heating and cooking on a commercial and economical basis; the construction of telephone lines, &c. As the price is given of every article enumerated, and illustrations are given of many hundreds, the publication will be found of the utmost utility, in one way or another, to all engaged in the electrical industry.

Richmond and Electric Lighting.—On the adjourned decision of the Electric Lighting Committee's report, Councillor Heasler last week moved: "That the electric lighting of certain streets be adopted, and that a contract be entered into with Messrs. Latimer Clark & Co. for that purpose." He said that the streets proposed to be illuminated were Kew Road, from the fountain to the bridge, George Street, Duke Street, King Street, Hill Street, Hill Rise, as far as Friar Stile Road, and Sheen Road, from the fire engine station to the corner of Church Road. Forty-eight single, nine double, and five triple gas burners could be dispensed with. The 40 arc lamps which it was proposed to distribute in the thoroughfares named would give from five to eight times the light of the present gas lamps. The average distance between the lamps in the centre of the town would be from 40 to 50 yards, and from 50 to 60 in the outlying parts. If about 18 lamps were put out at midnight the annual charge would be £360. So that the extra cost of the electric lighting would be £109, and £70 with a partial extinction at midnight. The motion was lost, an amendment postponing the matter being carried by a majority of two.

Triggs v. Elmore's French Patent Copper-Depositing Company, Limited.—In the Queen's Bench Division of the High Court of Justice, on Wednesday, the 20th inst., Mr. Justice Wright (sitting as an additional judge of the Chancery Division) had before him a motion by the plaintiff in this action to have it declared that the sum subscribed by certain debenture-holders (of whom the plaintiff was one) was returnable in proportion to the amount of their subscription. Counsel for the plaintiffs said that the French Company proposed to issue £65,000 first mortgage debentures, and they issued circulars inviting the shareholders to subscribe. It was stated that if the debentures were not fully subscribed the amounts would be returned to the subscribers. Only £2,000 or £3,000 were subscribed, and that was paid into Martin's Bank. Under these circumstances the plaintiffs applied for the return of their money, the company having gone into liquidation, and the bank claiming a lien in respect of an overdraft. A discussion ensued, and, as the result, the defendants agreed that there should be an order for the money to be repaid to the subscribers, the costs of the plaintiffs being provided for. The position of the bank was, that they had no objection to pay the money over, but they could not do so without an order of the Court.

Electrical Sanitation at Worthing.—On Saturday last M. E. Hermite, of Paris, accompanied by M. Emile Gautier, of the Paris *Figaro* staff, and Mr. C. F. Cooper, electrical engineer, of London, paid a visit to Worthing with a view to ascertaining the practicability of adopting M. Hermite's method of treating sewage by electrolysed sea water. A yard in West Street was selected and visited by the gentleman named, in company with members of the Corporation, and it was considered a suitable place to inaugurate the experiment—the first of its kind in this country—at an early date, as soon as M. Hermite can forward an electrolyser. Subsequently M. Hermite was interviewed at the Royal Hotel, and gave interesting details of the working of his scheme on the Continent and elsewhere. He stated that Worthing possessed especial facilities for the adoption of his plan, and urged that all microbes, not only of typhoid, but of every other disease, would be destroyed in a time varying from ten minutes to two hours by the electrolysis. The method, he said, was perfectly practicable, very cheap, and could be put in force with but little sacrifice. The sewage would be treated in the houses to which the sea water was laid on.

The Electric Light for Fleetwood.—On Wednesday last week an exhaustive report on the electric lighting question was laid before the Fleetwood Improvement Commissioners. It was the opinion of the committee that the total capital required for a complete installation would not exceed £11,000. The system recommended for adoption is the high tension alternating system, with suitable transformers. Tenders were received from the following selected firms, viz.:—C. A. Parsons & Co., Newcastle; Siemens & Co., London; Greenwood & Batley, Leeds; Andrews & Preece, Bradford; and the Brush Electrical Engineering Company, London. The tenders ran between £6,500 and £8,700. The committee recommended that the Brush Company's tender be accepted, but the board decided to consider the question at a special meeting.

Connolly Bros.—This firm have now completed the equipment of the works they have acquired at Blackley Vale Mills, Blackley, Manchester, and state that they will be ready to undertake the prompt execution of orders after January 1st, 1894. The works cover over one and a half acres of ground. They have been specially adapted by Messrs. Connolly for the manufacture of every description of insulating material and insulated wires and cables, and have been fitted up with the most modern plant of machinery and appliances which extensive practical experience, acquired in some of the leading works of England, the United States, and various parts of the Continent of Europe, can suggest.

Edison-Bell Phonograph Corporation v. Edison Phonograph Company.—This case came on for hearing before Mr. Justice Day, sitting without a jury, in the Queen's Bench Division, on Thursday. The action was for an injunction to restrain the defendants, who carry on business in Fore Street, from infringing two patents. Sir R. Webster, Q.C., Mr. Moulton, Q.C., Mr. Bremner, and Mr. Graham, were the counsel representing the plaintiffs; the defendant company did not appear. The case for the plaintiffs was that the defendants had infringed two patents relating to Mr. Edison's phonograph. The infringement was the sale and use in this country of a phonograph imported from America, and which was made under Mr. Edison's patents. Evidence was called to prove that the patents were vested in the plaintiffs, and that the defendants had sold an instrument made in accordance with them. Mr. Justice Day granted an injunction, and directed an enquiry as to damages. He also gave the plaintiffs an order for the costs.

Dundee Exhibition Lighting.—Messrs. Burt & Co., engineers, Glasgow, have obtained the contract for lighting the Dundee Exhibition with an installation of 10 arc and 25 incandescent electric lamps, besides supplying incandescent lighting to stall-holders, all driven by a powerful Acme gas engine, similar to that driving the electric light at Celtic Park. The same firm are also showing a smaller Acme gas engine driving a private installation for a Dundee electrical engineering firm.

Electric Lighting at Newcastle.—The electric light plant, which, for some time past, has been in course of installation at Chesters for Mr. N. G. Clayton was put in operation a few days ago, for the first time. Altogether in the house, stables and offices, there are some 500 incandescent lamps, and a very ample illumination is afforded. The installation has been arranged and carried out by Messrs. A. A. C. Swinton & Co., of Westminster.

Lighting of Llanhilleth.—At a recent meeting of the Abertillery Local Board, it was stated that the inhabitants of Llanhilleth were asking for a few lights from Aberbeeg to Andrew publichouse. The matter of lighting by electricity cropped up, and it was agreed that, so far as practicable, the road be lit by electricity from the adjoining colliery at a cost not to exceed that of the other lamps.

Printing Telegraph Company of Agence Havas v. Grist.—Mr. Justice Wills, sitting without a jury, had before him this case the other day. It was an action to recover a sum of money alleged to be due as calls upon shares taken by the defendant on an underwriting agreement. No appearance was entered on behalf of the defendant, and judgment was given for the plaintiffs for £392 and costs.

Calendars, &c.—The Commercial Cable Company have sent us one of their 1894 almanacs. Next year marks the closing of the first decade of the company's existence.

From the Brush Electrical Engineering Company we have received a nice little waistcoat pocket calendar for 1894. It is exceedingly neat, of very convenient size, and tastefully bound.

Presentation.—On Wednesday last week, at the works of Messrs. W. T. Goolden & Co., Mr. William Hey was presented with a beautiful marble timepiece and set of bronze figures, by the staff and workmen of the firm, as a token of esteem on his resigning the position of foreman in the dynamo factory. Mr. Hey had been with the firm nine years, and was much respected.

Chelmsford Electric Lighting.—The Electric Lighting Committee have had the contract for electric lighting the town renewed for five years. There was a somewhat lively discussion at the Town Council's meeting the other day regarding overhead wires, and in the end the matter was left for the Board of Trade to decide.

Weybridge and the Electric Light.—A special meeting of the Lighting Inspectors was held last week. It was decided to forward a letter to the Weybridge Electric Supply Company, Limited, accepting the offer for renewal of the lighting contract, subject to the wires being laid underground.

Wood Carving Company.—We are notified that Mr. George Driver has ceased to act as agent to this company, who have opened a London office on their own account at St. Pancras Chambers, 90, Queen Street, Cheapside,

Electricity in Mining.—Amongst other improvements which have been effected at the Aberdare-Merthyr Collieries, electricity has taken the place of steam power for working the pumping arrangements below ground.

Electric Light at Dundee.—The burgh engineer and electrical engineer have been authorised to experiment, at a cost not exceeding £10, on one of the dials of the old steeple clock, with a view to lighting it up with electricity.

Prison Electric Lighting.—We understand that the electric light has been installed at the prison of the little town of Vaetz, a few miles from Buda Pesth. Every cell is illuminated.

Tunbridge Wells Electric Lighting.—The Town Council last week resolved to instruct Mr. Preece to prepare plans and specifications for the new buildings, machinery, and central station for electric lighting.

Mildenhall and Electric Lighting.—The Lark Roller Flour Mills have been fitted with the electric light by Messrs. W. J. Crampton & Co., of Cambridge.

Warminster Electric Lighting.—It has been decided to light the Market Place by electricity.

CITY NOTES.

Woodhouse & Rawson United, Limited.

YESTERDAY, at Cannon Street Hotel, was held the first meeting of creditors in this company.

Mr. STEWART, whose statement of affairs we refer to in another column, addressed the meeting. In his opening remarks he stated that his observations of affairs had been necessarily delayed by reason of the statement of affairs having only been submitted by the directors on November 30th. That delay was accounted for by the directors by the fact that the books were in a very imperfect condition. They had not been written up for three months, and at the present time there is £28,000 still unaccounted for. The directors have been called upon to furnish further explanations of that deficiency, and until that was done he could not say he was satisfied they had had a thoroughly correct statement of affairs before them. He commented in detail upon the matter of the speculative business being carried on, whereas the company was stated to be an industrial one. The losses on the industrial business, leaving out the asserted profits on the floating of other concerns, for the years 1890, 1891, and 1892, two of which years 15 per cent. was paid on the ordinary shares, were respectively £13,246, £43,000, and £129,000. After remarking upon several items, goodwill, value of the Epstein accumulator, &c., he stated that the Official Receiver was of opinion that every enquiry was desirable, and he proposed to apply for a public examination of certain officials of the company in order to test the declaration. The main points were—(1) the distribution of dividend, (2) dealings with a certain guarantee fund, (3) the question of the finance and promotion business which had been undertaken by the company.

Some lengthy observations were made Mr. F. L. RAWSON, Mr. SAMUEL POPE, Q.C., Mr. LESLIE, and a number of creditors. Ultimately a resolution was passed, appointing Mr. Stewart to continue as liquidator. A committee was formed, consisting of five creditors who were not shareholders, in order to assist the liquidator in realising the company's assets. The members of the committee are—Messrs. Dodson, Hampton, Bond, Cox, and Ellenor.

Subsequently a meeting was held, at which Mr. STEWART addressed the shareholders much in the same manner as he had laid the facts before the creditors.

After some very warm and violent language had been engaged in, which, by the way, was protested against by the Messrs. Rawson and Mr. Pope, Mr. Stewart was appointed to continue as liquidator, and a committee of five shareholders were appointed to confer with the creditors' committee. The shareholders appointed were Messrs. Squires, Bond, Pilling, Sir James Lawrence and Dr. Duncan.

A vote of thanks to Mr. Stewart terminated meetings which lasted about 3½ hours.

The Swan United Electric Light Company, Limited.

THE directors' eleventh annual report for the year ending September 30th, 1893, presented at the ordinary general meeting of the company held at the Westminster Palace Hotel, Victoria Street, Westminster, S.W., on Wednesday last, 20th inst., reads as follows:—

"The profit and loss account for the year shows a credit balance of £28,877 9s. 6d., which, together with £6,824 17s. 9d. brought forward from the last account, leaves disposable the sum of £35,702 7s. 3d. An interim dividend in respect to the first half of the year, amounting to £9,376 15s. 9d., has already been paid. The board proposes that a further sum of £18,012 19s. be divided, free of income tax, and that £8,312 12s. 6d. be carried forward. The distribution of this amount, in accordance with clause 77 of the articles of association, works out at 3s. 6d. per share on the 78,949 ordinary shares of the company, £3 10s. paid, and 4s. 3d. per share on the 19,750 £5 fully paid, being equivalent to 7½ per cent. per annum on the partly paid, and of rather less than 7½ per cent. upon the fully paid shares. The warrants will be issued on December 23rd to the shareholders standing upon the register upon December 12th. The shareholders may be reminded that Messrs. Quilter and Swan were deputed to meet Sir John Lubbock and the Earl of Lichfield, acting for the Edison and Swan Company, with a view of suggesting a basis on which an amalgamation with this company could be effected. This basis having been generally agreed upon, it became necessary to ascertain in the first instance whether the fully paid-up shareholders of this company are prepared to accept the terms. Messrs. Quilter and Swan have now by circular addressed each fully paid shareholder, with a view of ascertaining whether they approve of the amalgamation of the companies on the arranged basis. As soon as this has been ascertained, the matter will be brought before the partly paid shareholders, and, if approved, a general meeting will be called to give effect thereto. The directors who retire by rotation are Mr. W. Cuthbert Quilter, M.P., and Major Flood Page, who being eligible, will offer themselves for re-election. Messrs. Welton, Jones & Co., the auditors, will also retire, and will offer themselves for re-election."

The eleventh annual general meeting of the shareholders of the above company was held on Wednesday (20th inst.) at the Westminster Palace Hotel, the chairman (Mr. J. S. Forbes) presiding.

The SECRETARY (Mr. H. Charles Gover) having read the notice convening the meeting, the report and balance-sheet was taken as read.

The CHAIRMAN said, in his opinion, it would be most convenient for him to begin his remarks by referring to the balance-sheet, which, with a view of certain possible contingencies, had been made up as a final or winding-up balance of the affairs of the company. He was under the necessity of apologising to the shareholders—first, for bringing them to the West End; and secondly, for meeting three weeks later in the year than usual. In the first case they were unable to hire a room in the Cannon Street Hotel, and in the second case the

delay was necessitated in consequence of the amalgamation with the Edison-Swan Company, for during that interval (should the amalgamation be carried out) the point had been reached where the responsibility of the directors of the Swan United came to an end, and the responsibility of the proprietors would begin. In order to ascertain what the Swan United were to be paid for the remnant of their business, and in order to arrive at that, it was thought that the best plan would be to get two gentlemen understanding the affairs of the company to arrive at some basis of an agreement. That had been done. The whole matter was very much complicated by the relative positions of the fully paid up shareholders and the partially paid shareholders in the Swan Company. Mr. Swan, representing the fully paid, and Mr. Cuthbert Quilter, representing the partially paid shareholders, met and put their heads together to see what would be the fair way of dealing with the cake when it was cut. Then they had to consider the size of the cake when distributed. Sir John Lubbock was good enough, in conjunction with the Earl of Lichfield—to consider the question from the point of view of the purchasers, Messrs. Quilter and Swan acting for the company. After prolonged negotiations a basis had been arrived at, not only as to what the Edison & Swan Company was prepared to give for the residuum of the Swan United business, but as to how the purchase price was to be divided between the fully paid up and the partially paid up shareholders. The conclusion arrived at seemed to be equitable—especially so in a case where the factors were partly existing and partly problematical. The Edison-Swan Company had agreed to give £100,000, in the shape of 4½ per cent. debenture stock, forming a first charge on the whole income. It was to be remembered that this was an extremely safe guardient against the rest of the capital, for not only was this 4½ per cent. stock a first mortgage having priority over all other charges, but the interest was accumulative. This was a great advantage. He (the chairman) had arrived at the conclusion that this would be a very good bargain for both sides. First of all, it would put the two companies under one umbrella; and, secondly, it would strengthen their hands against the severe competition in England and abroad, and enable them to effect economies which could not fail to be of advantage to the united bodies. The chairman then proceeded to deal with the credit side of the profit and loss account. The sales, less commissions and allowances, were £10,346 18s. 5d.; transfer fees and interest, £646 4s. 7d.; dividend on shares in La Compagnie Générale des Lampes Incandescentes, £878 6s. 4d. The dividends on shares in the Edison and Swan United Electric Light Company, Limited, was £24,826 4s. 4d., to which was to be added a further sum of £6,000, which was brought in because the theory of the amalgamation was that there would be a merger of the companies from October 1st, and in a winding-up balance, it was essential to bring into that account all which belonged to the Swan United, and not merely an asset in the transfer of the property. The dividends received from the National Telephone Company amounted to £1,123 8s., and he thought that the board had acted wisely in withdrawing available capital from last year's investments, and placing it in the National Telephone Company, where they got 5 per cent. In his opinion the shares would increase in value. The stock was represented by £8,507, but last year it stood at £14,654. The reduction had been made partly by sales and partly by working down the stock by way of depreciation. This lamp business required a large capital to carry it on, on account of the large number of patterns which must be kept on hand. This £8,000 simply represented the stock in Germany, for under their agreement with the French company, they were precluded from selling lamps outside of Great Britain, except in Germany. The debtor side of the account showed a balance of £28,877 9s. 6d. Referring then to the balance-sheet, the chairman said the share capital remained where it was, £375,000. On the creditor side the patent rights were set down at £327,063 12s. 4d. Out of the balance of £28,877 9s. 6d. it was proposed to pay a dividend which, with the interim dividend, would bring up the dividend for the year to 7½ per cent.; £8,312 would then be carried forward. The Chairman moved the adoption of the report and accounts as received.

Mr. W. CUTHBERT QUILTER seconded.

Major STROUD wished for further information as to the value of the patent rights of the two companies. They were set down at about £700,000; but as many of the patents had expired, and so were not worth a penny, would it not be better to strike out the nominal values, and so show the real value of the assets? The French assets (£30,489) were valuable.

The CHAIRMAN agreed that the expired patents were no longer valuable as an asset. When the agreement with the French company expired, the Swan United would be at liberty to sell lamps in all parts of the world, and not merely in Germany.

Major STROUD said the Germans were exporting lamps at 1s. per lamp. He had made enquiries amongst dealers. He wished to know whether, in the opinion of the chairman, they would be able to hold their own in the lamp trade against the German manufacturers.

The CHAIRMAN pointed out that the company's lamps were better appreciated in the market than those manufactured in Germany. Experience showed them that the lamps could not be made much cheaper (if at all) in Germany than in London.

Mr. F. W. REYNOLDS asked, with reference to the £100,000 debentures, whether there would be any cutting down of the capital? also would the liability to pay 30s. per share still remain?

The CHAIRMAN said there would be a loss on paper of £69,000, and the liability to pay up the 30s. per share would still remain.

The report and balance-sheet were then adopted.

The CHAIRMAN then moved, "That in addition to the £9,376 15s. 9d. already distributed in respect of the six months ended March 31st, 1893, a further sum of £18,012 19s. be divided, free of income tax; to be distributed in accordance with the provisions of clause 77 of the articles of association, making a total distribution for the year of £27,389 14s. 9d., being at the rate of 10 per cent. for the half-year, and making 7½ per cent. for the year ending September 30th, 1893."

Mr. W. CUTHBERT QUILTER seconded.

Carried unanimously.

The CHAIRMAN: You will receive your certificates on the 23rd—just in time for Christmas. (Laughter.)

Two retiring directors, Mr. W. Cuthbert Quilter and Major Flood Page, were re-elected unanimously.

The auditors (Messrs. Welton, Jones & Co.) were re-elected.

A cordial vote of thanks to the chairman terminated the proceedings.

Elmore's French Patent Copper Company.

A MEETING was held on Wednesday at the Holborn Restaurant of the debenture holders and secured creditors of Elmore's French Patent Copper Depositing Company, to consider a scheme of arrangement between the company and its creditors. Mr. C. J. Stewart, the Official Receiver and provisional liquidator, presided. It was explained that the object of the scheme was, first, to satisfy the claims of the debenture holders and creditors of the company; and, secondly, to resuscitate the company, so that the reversion of assets might belong to the shareholders.

The OFFICIAL RECEIVER having stated that he presided under an order from the Court, said he wished to make it very clear that he did not recommend the scheme in any form whatsoever. If it were adopted, those present must distinctly understand that it was not a scheme recommended by the Official Receiver. He did not say that the scheme was not the best one that they could adopt, but at the same time they must judge for themselves as to whether they would adopt it.

The scheme was adopted with one dissentient.

In the afternoon a meeting of the unsecured creditors was held.

Mr. STEWART, the Official Receiver, who again presided, explained that the debenture holders had accepted the proposed scheme, and it now rested with those present whether they would accept it. Practically the scheme put an end to the liquidation proceedings. He did not, as Official Receiver, wish to hold out any inducement to them that they would be benefited in any way by the scheme. The scheme having been read and explained, the Official Receiver said the creditors were best able to judge from their former dealings with the Elmore Company whether the new company was likely to be the success which had been foreshadowed.

On the motion of Mr. JOHN HEAL, seconded by Mr. SHURMER, it was decided to approve the scheme, subject to the sanction of the Court.

The shareholders of the company subsequently held a meeting at the Holborn Restaurant, under the chairmanship of the Official Receiver, who repeated the observations made at the earlier meetings, to the effect that he made no recommendation one way or the other with regard to the scheme. In reply to questions, he said the Court might decline the scheme, and anybody might be heard before the Court in opposition to it. It was, however, doubtful whether the Court would vary the scheme at all without a fresh meeting. After some discussion the meeting approved the scheme subject to the sanction of the Court.

The Parisian Popp Compressed Air Company.—The year's working of this company for 1892 closed with a loss of 3½ millions of francs, 500,000 francs of which are due to other years, and 2,800,000 francs to 1892. The loss resulting directly from the working is 960,000 francs. The expenses for first establishment again figure for 35,0 0,000 francs, and creditors in current accounts for 29,380,000 francs. The Berlin Discount Society has the largest interest in the concern.

Eastern Telegraph Company.—The directors announce the payment of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the preference shares for the quarter ending December 31st, and the usual interim dividend of 2s. 6d. per share on the ordinary shares for the quarter ended September 30th.

Aluminium Company.—Mr. Justice Wright, on Wednesday, had before him a petition by the company for the reduction of its capital from £400,000 to £80,000, by reason of loss of capital. His Lordship directed the petition to stand over for further evidence as to the loss of capital sustained.

The West Coast of America Telegraph Company.—The coupons due December 30th, 1893, on the debentures of this company will be paid by Messrs. Barclay & Co., Lombard Street. Coupons should be left two clear days for examination.

Western Union Telegraph Company.—A quarterly dividend of 1¼ per cent. has been declared by the directors.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending December 17th, 1893, amounted to £905; week ending December 18th, 1892, £918; decrease, £13; total receipts for half-year, 1893, £20,037; corresponding period, 1892, £19,894; increase, £143.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 15th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £5,215.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, December 13th.	Closing Quotation December 20th.	Business done during week ended December 20th, 1893. Highest.	Lowest.
184,500£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101 —104	...	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	42 — 45	42 — 44	..	...
2,932,680£	Do. do. 6 p. c. Preferred	Stock	81 — 82	80½ — 81½	81⅝	80⅛
2,932,680£	Do. do. Deferred	Stock	7¼ — 8	7¼ — 7⅝	7⅝	...
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜ — 12¼	11⅜ — 12¼xd	12 1/16	12
18,700£	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	108 —112	108 —112	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅝ — 2⅞	2⅝ — 2⅞	2⅞	2⅝
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2¼	2⅛
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	105 —107	105 —107	...	...
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	4½ — 5	4½ — 5	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000£	City and South London Railway	Stock	28 — 33	28 — 33	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11½ — 11⅝	11½ — 11⅝	11½	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12⅝ — 13¼	12⅝ — 13¼	13 3/16	13
10,000,000$	Commercial Cable, Capital Stock	$100	140 —150	140 —150 xd	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	10/-	1/16 — 3/16	1/16 — 3/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	4 — 4½	4 — 4½	...	...
50,000£	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	96 —101	96 —101	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 11⅝	11⅜ — 11⅝	11⅝	11½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15 — 15¼	15 — 15¼	15¼	15
70,000	Do. 6 p. c. Preference	10	15½ — 16½	15⅝ — 16¼	15 15/16	...
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	114 —117	114 —117	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15½ — 15⅝	15½ — 15⅝	15⅝	...
62,700£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
222,800£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	114 —117	114 —117	117	...
108,700£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
146,800£	Do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	...	...
200,000£	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	106 —109 %	106 —109 %	...	...
120,000	Electric Construction, Limited, Nos. 1 to 120,000	£2	... ...	½ — 1	1 1/16	...
12,845	Do. do. 7 p. c. Cum. Pref., Nos. 1 to 12,845	2	... ...	½ — 1	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	... ...	... ...	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛ — ⅜	⅛ — ⅜	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	0 — ¼	0 — ¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	½ — 1½	½ — 1½	...	...
180,227	Globe Telegraph and Trust, Limited	10	8⅛ — 8⅜	8⅛ — 8⅜	8⅜	8 1/16
180,042	Do. do. 6 p. c. Preference	10	15½ — 15⅝	15½ — 15⅝	15⅝	15½
150,000	Great Northern Tel. Company of Copenhagen	10	20 — 20½	20 — 20½	20⅛	...
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	104 —107	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21½ — 22½	22¼	22 1/16
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 43	40 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1 — 2	1 — 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4½ — 4⅝	4½ — 4⅝	4 7/16	4 1/16
15,000	Do. do. fully paid	5	6½ — 6⅝	6½ — 6½	6⅝	5⅝
37,500	Liverpool Overhead Railway Ordinary, fully paid	10	5⅝ — 5⅝	5 — 5¼	8¼	4⅜
6,295	Do. do. Pref., £6 paid	10	6⅛ — 6¼	6⅛ — 6¼	6⅛	...
37,548	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£10 paid)	10	7⅜ — 8¼	7⅜ — 8¼	8 1/16	...
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	103 —106	103 —106	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	½ — 1½	½ — 1½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	2 — 3	2 — 3	...	...
484,597	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ — 5	4⅜ — 4⅝xd	4 13/16	4 11/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	13½ — 14½xd	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13¾ — 14½	13 — 14 xd	...	...
119,234	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5¼ — 5½	5½ — 5⅝xd	5 5/16	...
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid	...	113 —115	113 —115	114½	113½
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4½ — 5½	4½ — 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼ — ...	⅜ — ...	...	...
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	102 —105	102 —105	...	...
11,802	Reuter's Limited	8	5½ — 6½	5½ — 6½	...	...
19,980	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	5⅝ — 6¼	5⅝ — 6	5⅞	5½
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	7⅞ — 8¼	8¼	...
3,381	Submarine Cables Trust	Cert.	113 —118	114 —119	118	116
78,949	Swan United Electric Light, Limited ... ... (£3¼ only paid)	5	2 — 2½	2¼ — 2⅜	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	36 — 38	36 — 38	37	36½
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	104 —107	105 —108	106½	...
58,000	United River Plate Telephone, Limited	5	2 — 2½	2 — 2½	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ — 6½	...	...
260,900£	Do. do. 5 p. c. Debentures	100	98 —101	98 —101	...	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	2⅝	2⅜
150,000£	Do. do. 8 p. c. Debs., repayable 1902 ...	100	99 —103	99 —103	...	...
64,242	Western and Brazilian Telegraph, Limited	15	6 — 6½	6 — 6½	...	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5¼ — 5½	5¼ — 5½	...	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1⅛ — 1⅜	1⅛ — 1⅜	...	...
178,200£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
222,700£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	..
88,321	West India and Panama Telegraph, Limited	10	1 — 1⅛	1 — 1⅛	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9⅜ — 10¼	9⅜ — 10¼	9⅜	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½ — 9½	8½ — 9½	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	108 —111	108 —111	110	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	113 —118	113 —118	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	102 —105	102 —105	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5 — 5½	5 — 5½	...	...

‡ Unless otherwise stated all shares are fully paid.

† Quotations on Liverpool Stock Exchange.

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid) 5¾—6¼.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent. premium, 106—108.—Electric Construction Corporation 6 per cent. Debentures 87—92.—Electric and General Investment, shares of £5 (£1 paid), 1¾—2⅛.—Founders' shares, 200—225.—Electricity Supply Corporation, Ordinary of £5, 5—5¼.—House to House Company (£5 paid) 1—1½.—Do. 7 per cent. Preference of £5, 5¼—5¾.—Do. 6 per cent. Debentures of £100, 101—103.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 4¾—5½, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6¼—6⅝.—Liverpool Electric Supply, £5 (fully paid) 6¼—6⅜.—Do. £3 10s. paid, 4¼—4⅜.—London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛—Manchester Edison and Swan Company £9 (£1 paid), ⅛—⅜.—Queen Anne's Mansions Lighting and Heating 6 per cent. £100 Debentures, 101—103.—Yorkshire House-to-Hou Electricity Company, £5 Ordinary Shares (£4 10s. paid) 4½—4⅝.

Bank rate of discount, 3 per cent. (October 5th, 1893.)

THE BRISTOL RECORDING VOLTMETER.

FOR some time there has been a demand in electric light and power stations for a voltmeter which would make a continuous record day and night of all changes of voltage. It has been shown by tests that the life and efficiency of incandescent lamps are greatest when the voltage is evenly maintained. When it rises above that for which the lamps were

FIG. 1.

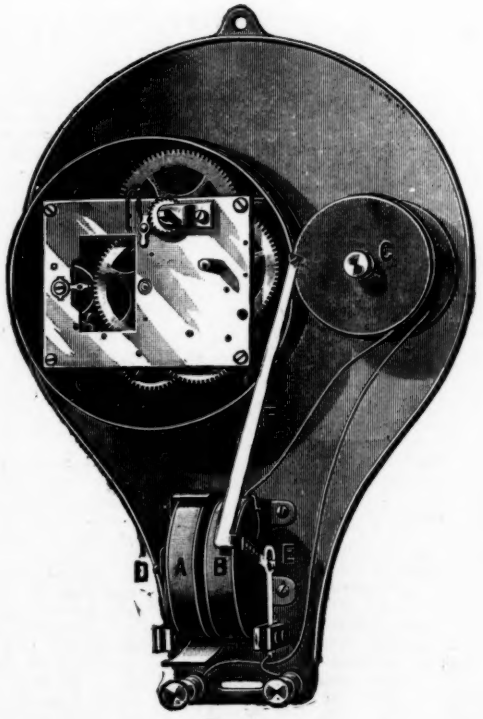


FIG. 2.

designed, even though the lamps may not be burnt out, they are liable to be seriously injured. If voltage falls below the normal, the result is deficient illumination and dissatisfaction of consumer.

The figures show a new recording voltmeter introduced by Messrs. J. W. and C. J. Phillips, 23, College Hill, London, E.C., which is extremely sensitive in its action and simple in construction. The coil, A (fig. 2), is mounted on the spring knife edge supports, D and E, and is free to move towards the parallel and stationary coil, B, when they are mutually attracted to each other by a current passing in series. The current is conducted to the movable coil, A, through the supporting springs, D and E, and this, together with the special feature of the moving coil being mounted on frictionless spring knife edges, renders the instrument extremely sensitive to the smallest changes of voltage. The marking arm, F, is attached directly to the spring, E, and partakes of its motion, recording the changes of voltage on a uniformly revolving chart. It will be observed that the instrument is constructed on the electric balance principle without permanent magnets.

The divisions on the chart are on an increased scale in the vicinity of the voltage to be maintained, thereby making it possible to note the variation of one volt. The chart shown in fig. 1 is intended for a 110-volt circuit, but the instrument is equally well adapted to any other desired range of voltage, as, for instance, one of 600 volts for electric railway work. The coil, C, is an auxiliary resistance. With the alternating current voltmeter the auxiliary resistance is furnished in a separate rheostat, which may be adjusted to suit the rate of alternations of the current to be measured. Several of these voltmeters have been in use in large electric light stations for the past three months, and are giving the highest satisfaction. At the World's Columbian Exhibition the company had one of the instruments in operation at their exhibit in Machinery Hall and one in Electricity Buildings. Two of the voltmeters have been used by the Committee on Awards in connection with the life tests of incandescent lamps.

BLOCK SIGNALLING.—BOARD OF TRADE RETURNS.

THE Board of Trade returns showing the progress effected in the establishment of the block on the various railway systems of England and Wales, Scotland, and Ireland, now issued, bring us up to the end of the past year. From them we gather that on December 31st, 1892, the total mileage of railway open for passenger traffic was :—

	Double line.	Single line.
England and Wales	9,167	4,345
Scotland	1,267	1,559
Ireland	609	2,241
Total ...	11,043	8,245

Of this mileage, 10,953 double line and 6,394 single line is now worked under the protection of the "absolute block." Of what is termed the "permissive block," there is but 51 miles, 70 chains. Other short lengths on the several systems are worked by telegraph, single engines, train porters, &c. There is really but little line capable of being brought under the absolute block left open for the application of that system. It is interesting to note the rapid progress made in the use of the tablet and electric staff systems. No less than 2,496 miles of single line are now worked under its control. Having regard to the fact that both systems cannot be regarded as otherwise than modern inventions, so large an application goes far to show the extent to which they are appreciated by railway management. The mileage percentages of double line worked on the absolute block system now stands as under :—

England and Wales	99·5
Scotland	100·0
Ireland	96·0

Of the Irish railways, the Waterford and Limerick is the only exception to the *cent.* per *cent.* return. That shows a result of but 31 per cent.

The railways having now accomplished so much, it is to be hoped attention may shortly be directed to the interlocking of the electric with the mechanical signals. When

this is accomplished, our railway signalling arrangements will be such as we may well be proud of, but until that is done it is impossible to regard them as complete. At the present moment, as we have more than once pointed out, the two are disjointed—the one may be, and in point of fact is, worked independent of the other. It is to be hoped that no time will be lost in combining them, so that the one cannot be worked without the other.

UNDERGROUND WIRES FOR ELECTRIC LIGHTING AND POWER DISTRIBUTION.*

By D. C. JACKSON.

THE advantage of placing all electric wires underground has been recognised from the very birth of the electrical industries (some of the earliest telegraph lines having their conductors buried), but difficulty of insulation and great first cost have prevented a general adoption of the system. Now, however, the unsightly appearance of overhead wires, and the obstruction of streets caused by pole lines, as well as the obstruction to firemen in cases of fire in high buildings, have led the councils in nearly all large cities to compel the electric companies to bury their wires, at least in the most crowded districts.

From the operating company's standpoint there are many advantages in an underground distribution system. Reliability and safety are the strongest arguments. Sleet, storms, fires, winds, and other similar causes of breakdowns in an overhead system are harmless when the wires are below the pavement. Underground wires have been operated for years without interruption, due to trouble on the lines when proper care has been taken in their insulation.

The methods of placing wires underground in this country are divided generally into two classes:

1. Solid, or built-in systems.
2. Drawing in or conduit systems.

In the first a conductor, insulated and protected in some way from mechanical injury, is buried, and cannot be reached for repairs except by tearing up the street. In the second class the conductors, either bare or insulated, are pulled into some kind of a conduit. They may be removed or repaired at any time, and additional wires to the full capacity of the conduits may be drawn in as they become necessary. For plants which are liable to grow, the drawing-in conduit system has proven altogether the best, and it is always easier to get at breaks and make repairs, without delay to the consumer or obstruction in the street. The first cost is slightly greater than that of the built-in system, but usually not enough to balance the advantages. The Edison tube is the only important example of the built-in system in this country, and while it is very successful on low pressure work, the difficulties of maintaining the insulation, particularly at the couplings and junction boxes, for high pressure work, bar it from general competition.

Drawing-in conduits of two classes have been used, insulating and non-insulating, but the former class have always failed to work, and have gone entirely out of use for underground work. If a perfectly insulating conduit could be built, into which bare wires could be safely pulled, there would be a great saving in cost, as the insulation of a cable makes up half the cost of an underground system. But since it has been found absolutely impossible to prevent the condensation of moisture on the inside of a conduit, the insulation due to the conduit cannot be kept up unless air can be completely excluded, particularly from manholes or junction boxes. Therefore, at present, the non-insulating conduit system is the method which is generally used for underground wires.

I.

A complete subway system consists of three parts—1, the conduit; 2, drawing-in manholes placed at convenient intervals; 3, arrangements to get at the cables for the purpose of service connections.

Anything which will keep open a hole, smooth enough on the inside not to injure the cables in drawing in, and strong enough to protect them from mechanical injury for an indefinite length of time, will do for a conduit, provided there be nothing about the material which will injure the covering of the cables.

Of the large number of conduits which have been used or proposed, there are at present in successful use in America, on a large scale, four typical forms: Iron pipe, which may be either cast or wrought; cement lined sheet-iron pipes; tile, terra cotta, or clay pipes, and wood tubes.

The most generally used are the earthenware conduits, and the most used of them is made of glazed terra cotta, in sections 3 feet long, with one or more rectangular ducts, each capable of carrying at least three cables. The walls are about 1 inch thick, and are supposed to be strong enough not to be cracked by the shock of street traffic when laid 18 inches below the street surface. Rectangular ducts have a considerable advantage over round ones, when the cables are properly drawn in. There is less trouble in drawing in several cables, as they may be arranged to lie side by side instead of on top of each other, and any one may be then withdrawn at any time without disturbing the others. The glaze of the ducts has quite a high electrical resistance; but this is probably a disadvantage, as the cable cover should be continuously grounded, to prevent shocks to linemen from static effects, or from leakage.

The terra cotta conduit is watertight and fairly gastight when properly laid, but moisture can never be entirely kept out of any conduit, and gas is found to get through even the best built walls, if it is present in the soil in any quantity. The lengths of the terra cotta sections are short enough, so that something of a bend may be made in laying; but as the bend is really a series of straight sections, with angles between them, it is rather difficult to pull cables around, and manufacturers recommend perfectly straight ducts. All irregularities on the inner surface are smoothed off before the tile leaves the factory, so there is no possibility of damaging the cable in drawing in, and there is nothing about the material that could possibly, by any chemical action, injure the lead covering of the cables, or make the withdrawal of the cables difficult after they have been in service a considerable time.

There is a great diversity of opinion as to the proper depth at which a conduit should be laid. The principal conditions affecting this are the presence and location of other pipes and obstructions in the streets; the amount of tearing up to which the streets are subjected, and the method of distributing wires from the conduits. By some it is claimed that it is well to go below the frost line, but as the material should be one not cracked by frost, this is not usually deemed necessary. City ordinances often affect the position below the streets and then the best is made of what may be unsatisfactory conditions. If it be possible, the depth of the top of the conduit should be about 2 feet below the pavement, when the conduit is laid in concrete, as at that depth there is no danger of cracking from the weight of heavy teams in the street, as has been the experience where clay conduit has been laid at less depth. If clay pipe is laid bare in the earth (*i.e.*, without concrete), it should be generally about 3 feet deep for absolute security. The tile conduit should be, and where the best results have been obtained is, laid in a bed of from 2 inches to 6 inches of concrete, and covered with concrete to that depth, so that when the whole has hardened it is like a continuous set of stone ducts. The top may be further protected by creosoted board if the conditions make it necessary. Joints between the sections are made either by wrapping the joint with several layers of burlap strips soaked in hot asphalte, or by means of a tile sleeve over the joint which is cemented on. The latter joint is usually used when the conduit is laid in concrete, and in laying the conduit it is then usually sufficient to simply bring the sections together in a line in a trench, and fill in with concrete.

The durability of this terra cotta conduit depends somewhat upon where and how it is laid. If excavations in the streets are frequent there is considerable danger of its being cracked by picks and other tools in the hands of workmen. When concrete is used the conduit will "stand alone," even if all earth be removed from around it for some distance, and ordinary street excavations will not disturb it, but if the excavation is not properly filled in, the whole construction may settle after a time and cause considerable damage. No natural deterioration of this material can take place. It is absolutely proof against heat and chemical action, so unless it be disturbed it should last for ever.

House services are sometimes taken off from this type of conduit by means of hand-holes, in front of each house, using a subsidiary duct of iron pipe running into the basement; and sometimes the service wires are taken from the manholes and carried into each block by the subsidiary duct, whence they are distributed overhead from roofs or otherwise. The all-underground method is the best, but it is more expensive, so it is less frequently used. In either case a subsidiary duct is necessary and for this iron pipe is undoubtedly best, and is recommended by all manufacturers. If a system has a considerable number of ducts, and hand holes are to be used, the top layer should be used for the distribution mains, so that the services can be readily taken off and shallow hand holes used. When for any reason the main conduit is laid quite deep, a separate duct or set of ducts should be run near the surface for distribution. Sometimes, in business districts, it is possible to supply a whole square from a single manhole, as the wires can run along under the sidewalks or pass through the partition walls of buildings. The method of distribution is practically the same for any of the forms of conduit in common use, except the Johnstone, which may be tapped into anywhere.

The experience of those who have used tile conduits seems to be very favourable, especially in the smaller cities. In Washington it is highly praised, both by the telephone and electric light companies, and telephone companies in Baltimore, Chicago, Pittsburg, Milwaukee, and other cities consider it successful.

In Milwaukee an ordinary cement sewer pipe has been laid in the same manner as the tile, with cemented joints, but no concrete, and it makes a very fair conduit, which is a little cheaper than the special forms. The pipes are softer than vitrified tile, and therefore more liable to mechanical injury, but the system has not yet been long enough in use to fully decide on its comparative merits.

The simplest of all conduits, and one which is used quite generally, is a common wrought-iron gas or steam pipe, either laid bare in the ground or in a bed of concrete. Ducts are usually of 2-inch to 3-inch pipes, and since a 3-inch pipe will carry four ordinary electric light cables, the system is economical of space in the streets. One cable can be pulled out when the others are in the ducts, but the practice of handling cables separately when several are in one duct is not advocated by the most experienced. Joints in the pipe are made with a sleeve screwed on with a vanishing thread, which is cut so that the ends of the pipe come close together inside the sleeve. The sections of pipe are generally 20 feet long.

When properly jointed, the pipe is, of course, watertight, but gases get into the manholes as in all other systems. The great advantage iron pipe has over all other forms of conduit, is its flexibility. It may be bent in any direction at any point, to avoid obstacles in the streets, and it should always be used when obstacles are particularly

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numerous. Some authorities claim that a conduit should never bend, but experience in New York and Chicago proves that cables can be pulled easily around several bends with radii of 3 feet or less.

The best method of laying iron pipe ducts is in concrete, with the pipes about one and one-half inches apart. It is sometimes best, as an extra precaution against mechanical injury, to box it in at least on the top and sides with creosoted plank. Pipe may be laid bare in the ground but it is then less durable. Iron has been found to have no bad effects on the lead covers of the cables, either while drawing in, or by chemical action after they are in, although it is possible for rust to so fill up the ducts that the cables cannot be easily withdrawn. The only bad feature of this form of conduit is its magnetic qualities. If an alternating current is carried through an iron duct, and the return wire is in another duct, the self induction is greatly increased and the loss of pressure is considerable. In one case where the effect of iron conduits upon the loss of pressure in electric light cables was tested the loss due to impedance was found to be a considerable factor.

Mr. Pierce finds a fall of pressure of 2 volts with a current of 7·2 amperes and resistance of ·0088 ohm, when the conductors are thus arranged. He concludes that the losses are due to two hysteresis and eddy currents in the pipe, and is consequently opposed to the use of iron for this purpose. A satisfactory commercial remedy for the effects is to put both sides of the circuit into the same duct, and as close together as possible. A great many cables used in some of the cities are made with the outgoing and incoming wires duplexed together for this purpose.

An iron pipe conduit is more secure against mechanical injury than any other kind, especially if it be laid in concrete and protected by creosoted planking. It is said by those having experience, that a labourer will try to dig around wood in the ground, when he will try to go right through concrete, so that wood is a considerable protection. Occasionally a crowbar, driven down into the street for an anchorage, will go through plank, concrete and all, but it will glance off the pipe unless it happens to strike very near the centre.

The greatest cause of deterioration in iron pipe conduits is oxidation. The amount of this in conduits cannot yet be determined, as they have not yet been in long enough, but other pipes when laid bare in the earth probably do not keep in good condition more than 25 years. If laid in concrete the inside of the pipe only will oxidise, and it is claimed that the pipe might be entirely eaten away, and yet leave a smooth duct through the concrete, but considering the quality of the concrete which is ordinarily used, this is very doubtful. In New York, before ventilating blowers were put in use, a greasy deposit was found on the inside of the conduit, and this seemed to protect the iron, but since the conduit has been thoroughly ventilated to avoid gas explosions this deposit has disappeared, and the pipes show the effect of rust to a considerable extent.

The distribution of wires from iron pipe conduits is made in a similar manner to that for tile conduits, a special tier of ducts being used for distributing mains only when necessary. The Johnstone conduit is sometimes used for distributing from wrought-iron pipe conduits. It consists of cast-iron sections 5 feet long, containing two rows of square ducts. This conduit is laid bare in the earth, and joints are made fairly tight with plumber's putty. Before every alternate house there is a removable top, and a place in the side of the conduit where a wrought-iron subsidiary pipe may be screwed in, making it possible to take off services without expensive hand-holes or manholes. This conduit must be laid quite near the street surface. Cast-iron lasts better in the earth than wrought-iron, so the life of this conduit should be fairly long; but of course the danger of mechanical injury is somewhat greater than in a properly laid wrought-iron pipe conduit with concrete. It lacks flexibility, and is quite heavy, but seems to be the only distributing system worked out in detail, and is quite successful in New York, which is the principal place where it, as well as the iron pipe conduit, is used.

Tubes of wood, treated with various substances to preserve them, have been manufactured by several companies and quite generally used. At present Philadelphia probably has in use a greater length of wooden conduit than any other city, though there is considerable of it in Chicago and Brooklyn. As used in Philadelphia it is made up of pieces, laid one above another, to give any desired number of ducts, and spoked down, the several pieces being kept in proper relative position by dowel pins. The thickness of the walls is about 1¼ inches, the top being usually covered with a 2-inch plank for extra mechanical protection. The commonest form of wood conduit is made up of 4-inch by 4-inch pieces of wood with a 3-inch hole bored through from end to end. These are jointed either by a male and female union, or by simply butting the ends together. For a preservative of the wood, oil of coal tar, carbolineum, and other compounds have been used. This conduit is by no means watertight, but with proper cables it has been quite successful. It is less flexible than iron pipe, but curves may be approximated by using short sections. One of the greatest advantages claimed for the wood conduit is its accessibility. The wood may be cut away at any point, and connection made to the cables, so that expensive hand holes are not needed, but generally when the wooden conduit is used the distribution is made from the drawing-in manholes. The greatest disadvantage of the conduits is the chemical effect of the preserving compound on the lead covering of the cables. The lead is entirely destroyed by chemical action in a short time when in the presence of wood preservative, unless it is protected by hemp braiding, alloying with tin, &c. Since the life of braiding is limited, and tin does not alloy evenly with lead, the rate of depreciation of cables in these conduits is usually great.

The durability of the wood is a matter of dispute. It is claimed that the preservative sinks in deeper with time, making the wood almost bone-like after it has been in the ground a few years, so that it will even turn the edges of the tools used to cut it. From the experience with wood similarly treated and used for other purposes, and what experience has been had with conduits, it seems that they should last at least 30 years, and probably much longer. Untreated wood, which is considerably used in Chicago, and elsewhere, will probably not last more than 15 years.

With regard to mechanical injury from the labourer's pick, the wooden conduit is as safe as any other, but a bar may be driven down through the ducts more easily than through iron pipe.

It is claimed in Philadelphia that wood makes the only really successful conduit, but there they have the advantage of a very efficient control of the underground structure which occupies the street, so that its principal disadvantages are not felt.

The only other type of conduit which is being used on a large scale is the cement-lined iron pipe. The tubes for this conduit consist of a tough sheet-iron shell, riveted and lined with ⅝ inch of pure cement, no sand being used, and the inside being carefully smoothed. The pipes are made in 8 foot lengths, and of various diameter. The weight per foot of 3 inch duct (which is generally used) is about 5 lbs., as compared with 7½ lbs. for wrought-iron pipe. It is claimed that the pipe is water and gas tight, and proof against acids and alkalies. Distribution is always effected from manholes or handholes, the subsidiary ducts being generally 1 inch wrought-iron pipes.

The cement-lined pipes cannot be bent, but some flexibility may be gained by using short sections connected together by ball and socket joints. Bends made in this way must be of large radius, or cables will not draw in satisfactorily. Clay and wood conduits, as already noted, have the same fault of inflexibility.

The cement being smooth inside, this pipe is one of the best to draw cables into that has been tried. It is probable that there is no deteriorating effect on the lead from the cement, although, under some circumstances, it has softened so as to hold cables fast. It is feared that the cement would crack off, but this does not seem to be the case. The tubes are laid in concrete, and protected exactly like the ordinary wrought-iron pipe.

The danger of mechanical injury is slightly greater than with wrought-iron gas pipes, as the sheet-iron is too thin to be a protection, but the danger is slight when properly laid in concrete. The cement tube, like terra cotta, should last for ever, if not mechanically injured, even if the iron becomes entirely oxidised, provided it be true that the cement does not crack or soften.

The main arguments made in favour of this style of duct are its durability, smoothness and cheapness, as compared with iron pipe.

All of these conduit systems are in successful operation on a large scale, but the period of use has not yet been long enough to prove positively that they will all endure satisfactorily. The users of each appear to be well satisfied. Which to choose for any new installation should depend on local conditions. When, as in New York, the streets are filled with a mass of pipes of all kinds, and a conduit may be broken into by a workman at any time, the flexibility and strength of the iron pipe are necessary, notwithstanding its greater first cost and probable greater rate of deterioration. Where underground work is temporary, as at the World's Fair grounds for example, or where cheapness is the main element, the wood conduits are the best. It is probable that their effect on the cable and lack of flexibility, balance the arguments in their favour (such as durability, continuity, and accessibility), except for the classes of work already mentioned. The arguments in favour of cement-lined pipe are smoothness and cheapness, and it doubtless makes a very satisfactory conduit where the special arguments in favour of iron pipes do not apply. For use where (as in most of the medium size cities of the country) there is still room in the street for a good-sized conduit without many bends, and where the amount of tearing up of the streets is not excessive, the vitrified clay conduit seems to be best, as its smooth ducts are easy to draw cables into. It does not injure lead, cannot deteriorate in the earth due to any chemical action, and is cheap. The Johnstone conduit is excellent for a distributing system, and would probably answer well where comparatively small capacity and no flexibility are necessary.

II.

For electric light cables, especially where several companies occupy the same conduit, larger manholes are necessary. This is a matter which depends altogether on local conditions, which is also true of much else connected with underground conduit construction.

An ordinary standard size for manholes is 6 feet square and 7 or 8 feet deep. When the conduit consists of few ducts, near the surface, a much smaller hole, 3 feet or 4 feet deep, may be used, with a large cover so that workmen can practically stand in the street while working at the cables.

The walls of the best types of manholes are of brick laid in cement, and sometimes the whole is coated with cement, but this is probably of little value, as the character and thickness of the walls is determined by the importance of preventions of gas and water from leaking into the manhole and avoiding the destructive effects of the vibrations caused by passing teams. A foundation of at least 6 inches concrete should be solidly put in for each manhole, as any settling is apt to throw the ducts out of line, and in the case of terra cotta to crack the conduit as well as disturb the street surface. Manhole covers are of cast-iron, and are placed on a ring casting set on the brickwork. This casting should be well fastened down by anchor bolts or something of that kind, to prevent cracks being caused from the effect of vibrations. The covers may be either single or double, but as the outside cover can only be held down by a stone weight, and never make a tight joint, the double cover is better if it is desired to keep the hole absolutely clean, but in nearly all cities single covers are used and fair results obtained. In Chicago, the telephone company uses a cover with one-half inch slots in it for ventilation, and still has no great trouble from dirt, although it is occasionally necessary to clean out the holes. The best form is where the inside cover is screwed down (much like the manhole cover of a boiler) on a rubber gasket, conse-

quently making the hole perfectly tight. The inner cover should be of a form that will drain all water away from the gasket, and where it can be readily bailed out when the hole is to be opened. When the streets of a city are fairly cleaned and well drained, and especially for small holes, the double cover is unnecessarily expensive, but in this case it is well to make the outer cover extra heavy, and to use a hemp gasket under it. When double covers are not used, connections from manholes to sewers are frequently made, and this should always be done where the location is such that there is any possible danger of filling with water.

Some arrangement should always be made for hanging the cables against the sides of the holes, so that any cable can be easily reached at any time, and so that men cannot easily use them for steps in entering a manhole.

Manholes made of cast-iron sections, creosoted lumber, and of concrete, have been, and are, used to some extent; but the best practice all over the country seems to favour the brick walls, as strongest and best, and fairly cheap.

For complete underground house-to-house distribution, some kind of manhole or distributing box is nearly always necessary. They are usually placed at the line of every second lot, two buildings being supplied from each box.

Handholes are of two types, surface and buried. The first has a cover like that of a manhole, on the suface of the street, and it is, in fact, a miniature manhole, with either single or double cover. The buried handholes have a cover below the surface, and are covered by the paving. When the box is used only for distribution, this pipe is probably the best, as it may cost a little less, and the pavement must be torn up clear to the hole in any event, when a service duct is to be put in. The presence of the iron covers every 50 feet in the street is objectionable. Handholes, which are simply boxes into which the duct open on each side, and in which there is a place for subsidiary ducts to enter, are generally about 2 feet deep, and are large enough so that joints in the cable may be made in them, 2 inches by 18 inches being a fair size. They may be built either of brick or of cast-iron. In the latter case the castings are frequently ring sections, built up to any desired height.

Some method of draining a conduit is necessary. The ducts may be laid on a slight slope, toward the manholes (which, themselves, should all drain to one point), and water may be allowed to gather there, to be pumped out occasionally from the street, or sewer connections may be made. The latter is unnecessary, if no water can get into the conduit except by condensation.

An even greater enemy than water to the success of an underground system is gas. In nearly all large cities the gas mains are in a leaky condition, and the soil is full of gas. If the pressure is any lower in the conduit than in the street, gas will flow in, no matter how tight the walls appear to be. The objections to this are two: (1) bad effect on workmen in manholes; (2) danger of explosion. The cause of gas in the subways, low pressure, suggests a method of keeping it out; that is, to maintain a pressure a little above that of the street, by means of blowers of some kind. This method has been a great success in New York. A special pipe (6 inches) is laid connecting the manholes, where openings of different sizes ($\frac{1}{8}$ inch to 1 inch) are made, depending upon the distance from the blower. A pressure of a few ounces per square inch is kept at the blower, and the gas seems to be entirely kept out, manhole explosions never occurring. The amount of air required is about 500 cubic feet per hour for a manhole, the amount for the conduit depending on the kind used. In New York about one horse-power is required at the blower per mile of subway. In cities of the second classes, where gas mains are kept in a fair condition, the pressure system is necessary. The most common way of ventilating, used very successfully in Philadelphia and many smaller places, and with moderate success in Chicago, is to connect the manhole by a pipe with a hollow electric light pole, so that the pole will act as a chimney. By this means the proportion of gas can be kept quite low, and it is not expensive if the poles are conveniently arranged. Otherwise the pipe must be carried up the side of a building or other convenient object.

The comparative cost of the different conduit systems is difficult to estimate, as it depends upon so many local conditions. It may be divided into cost of excavation and refilling, and the cost of material and laying the conduits. The first part will vary greatly with the kind of paving, depth of conduit, &c., but is nearly independent of the kind of duct used. The rate of depreciation of a subway has not yet been determined, but from the use of similar materials for other purposes, it may be estimated as being 4 per cent. or less for iron pipe, and less than that for any of the other kinds if they are properly protected from mechanical injury. The cost of maintenance should be almost nothing, but actual figures for the conduit alone cannot be obtained.

DISCUSSION.

T. D. LOCKWOOD: There is one thing, if there is nothing more, that the practical telephone man has to congratulate himself on, and that is, that if he is not a pioneer in anything else, he at least is in underground construction of electric wires. As early as 1882 the recommendation was made to the company with which I have the honour to be associated, that while it was thought to be impracticable, or, at all events, non-practicable to work telephone transmission by means of underground wires, it was at least worth trying, and it was tried. The first attempt at that kind of construction was simply iron pipes laid in concrete cement. Nobody knew how to make underground telephone cables or any other kind of cables then. The cables were drawn into these from manholes and that construction existed from 1882 until I think about 1888, when the pipes grew too small for the cables, and the entire structure had to be dug up and a new one put down. Of course, in any discussion on underground construction we have to think of the conduit first. It is not necessary to look out for insulation in a conduit, but for something to protect the insulation, namely, a protective structure which shall take care of the cables to be drawn in. I venture to say that the lines upon which success seem to have been attained in the construction of conduits, at least for telephone wires, are either the closed terra cotta blocks or else the cement-lined iron pipe. A difficulty which is frequently encountered is the constant attack upon lead covered cables of heavy currents which come to the earth from various and extraneous sources. All the tin alloy in the world will not prevent such attacks upon lead-covered cables. All the plastic or textile covering in the world will not protect lead covering; but even if it were possible, I think that the constant pumping of such currents into the earth on account of even gas and water pipes will ultimately have to be deprecated much more strongly than it is now. Every cable which is put down, and which is intended to do good practical work in telephone, telegraph, electric light or electric power service not only requires to have good electrical properties, but it ought to have good mechanical strength. Experience teaches me that for telephone work, at least, a cable covered with tin and lead, and that has enough lead to keep it stiff and enough tin to keep it from being easily damaged by the influence of creosote, or, more properly, the dead oil of tar, is all right. One of the most important features of the underground construction is not so much laying cables down and building conduits as building attachments at the end whereby to draw the wires out. It is quite necessary to have first class stuffing boxes that the cables can be drawn out without damaging the construction proper, and there is no reason, I think, no real reason, why underground cables should not be continued clear up to the place in which they are to be used, except, perhaps, the value of providing testing facilities between the earth and between the office cable and between the switchboard and other appliances in which it is to be used.

Mr. ABBOTT: A solid conduit is being introduced in Pittsburg, Cincinnati, Buffalo, and to a slight extent in this city. The conduit is made to obviate one of the difficulties that has been encountered in the rectangular forms; that is, the difficulty of drawing cables out. There is very little trouble in putting old cables into the ordinary rectangular form, but considerable difficulty is experienced in getting the cables out without entirely destroying the old covering. This objection has been overcome by building the conduit after the manner of a brick wall. A trench is excavated, the bottom is lined with concrete to form a suitable foundation on which to place the terra cotta structure, and then a series of the terra cotta bricks are placed. The joints of this subway are made by cementing the whole material with a fair quality of Rosendale cement. After the subway is constructed a scraper is drawn through each part of it, from manhole to manhole, so as to clear out all of the sand and to clean the glazed surface of the pipe. After that a stream of water is sent through each of the holes, so as to wash away everything left by the scraper. As a result, it has been found in this city that we have been able to get a cable in about 200 feet by hand without any tackle at all, and after remaining in the subway three or four months we have been able to pull the cable out without showing any abrasion of the surface whatsoever.

I. H. FARNUM: We have in Boston to-day over 8,000 miles of wire underground. The question of corrosion of the cables due to the action of the current from street railway lines, is one which has not been discussed this morning, or, at least, only touched upon by Mr. Lockwood. It is interesting, because if we put our cables underground and we find that in a few months they are destroyed, we have met something quite as objectionable as the destruction of wires overhead. I will endeavour to give you an outline of what we have discovered, and the method that we have taken to overcome the trouble. We find in Boston that the trolley wires came at first from the negative side of the dynamo and extended out over the city. The current, of course, in this case, the dynamo being grounded, would go through the rails to the trolley and back to the dynamo. Now, as we all know, the rails are not a part of the conductor, although they are reinforced in Boston by five large copper wires about the size of a piece of chalk, or a little larger. We have five wires between the rails, and yet the current flows largely through the earth. Now, our cables began to go to pieces from a cause not known, and in August, 1891, attention was called to the fact that electrolytic action was destroying the old cables. We found by measurement that all of the territory through the city, except a small portion near the power house, showed negative, and that this small portion was positive. Now it is evident that where current leaves the cable the electrolytic action takes place, and, as I have said, we found this condition to be true. It was suggested a few months afterward that the railroad circuit be reversed. If we made the contrary wire the positive side and the ground the negative side, it would naturally reverse this condition of things, and instead of having a large portion of the city in which the cable would be destroyed, we would confine it to a smaller portion, near the power house, and that was done. The trolley wire was then made positive, and it came from the positive side of the dynamo, and the earth was made negative. The current came out over the line and down through the car and into the ground, taking the same general course through the earth, but in the opposite direction. In this way the destruction of the cables was limited to portions of the city near the power houses. The larger portion of the city was then free from electrolytic action, while a portion near the power houses still showed that condition. We attempted to remedy the trouble to some extent by connecting the cables with the earth and by running the wire to a ground plate in each manhole, or in each underground apartment for the carrying of the cables, but this did no good whatever. Mr. Pearson, of the West End Railway Company, suggested that a heavy copper wire be extended from the power station and connected with the grounded side of the dynamo, and that this wire

be connected to our cables in a district where the corrosion was taking place. A wire about $\frac{7}{8}$ths of an inch in diameter was connected with the positive side of the dynamo. In every manhole the cables were united with this return wire. Excepting in some small portions of the city this has remedied the trouble for the time being. It may be interesting for you to know that notwithstanding the five large wires which are run through the streets in connection with the rails of this system in Boston, and in addition to these large return feeder wires which are run overhead about $\frac{7}{8}$ths of an inch in diameter, there is yet passing from our cables to this return wire hundreds of ampères of current. The main return wire, which is $\frac{7}{8}$ths of an inch in diameter, and is copper, is heated perceptibly by the amount of current which it takes back to the station.

A. W. HEAVISIDE: In England we have found with a very extensive drawing-in and drawing-out system, that if we take great care in details in having our pipes laid in short lengths in perfectly straight lines, straight in line and straight in section, we have no difficulties, but where once we introduce curves, either lateral or horizontal, the difficulties arise. In nearly every case where we have found that we could not draw cables, when we have dug up our pipes we found that to be the cause of the difficulty. You must have absolutely straight lines from draw-point to draw-point. It is also absolutely necessary that your system should be as hermetically sealed as possible. Your joints must be as perfect as you can make them all the way through, and your junction boxes must be hermetically sealed. I might speak of a system of underground electric light distribution which is followed in Newcastle, which I think has some features of novelty in the way in which the cables are dealt with at the points of junction, at the distributing points, and that is this: Concentric cables are used from point to point, and at the junction boxes these concentric cables are bare and placed upon porcelain insulators. Each insulator is so fitted with terminals that it practically becomes a test-box, and at any point you can sub-divide your system all over the city and distribute or rearrange your circuits according to circumstances. For instance, some imperfect cables may burn out, and in order to repair them and distribute over 10 miles of pipes through the city in an ordinary way, and under the most expeditious system that you could devise would take 24 hours, but we, fortunately, had an alternative. We immediately went to these distributing boxes, rearranged the connections, and the whole service was resumed within one hour.

A. J. DE CAMP: What are the merits or demerits of creosoted wood? What is the action of currents on lead-covered cables or any other metallic covering? What is the difficulty of pulling a number of wires in or out of a single conduit? On this last point I have had some experience. I have found that it was not impracticable to pull a given number of wires and proportionately a very large number of wires into a single conduit, nor was it a very difficult thing to pull any one of those wires out individually; but it was a very difficult thing, and well nigh impossible, to replace a single wire. There is another point which I think everyone is interested in, and which I apprehend there will be some difficulty in answering, and that is the effect of the current on this outer covering, which we relied upon to protect our insulation from moisture and mechanical injuries. The nearest that I can get to it, independent of the expense of putting in the cable, but not the bare cost of the cable itself, will be a matter of some $1,000 or $1,200 a mile. That cable, by reason of this action of the current which is going to destroy it in one, two, or three years, becomes a very serious matter. It becomes a serious matter if it is to be done in 10 years.

GEORGE W. BLODGETT: The superintendent of the Western Union Telegraph Company, in Boston, told me of a difficulty which the company had experienced in consequence of the trolley wire currents, which I thought it would be interesting for you to know. That company had quite a large office in Bangor, Me., grounded in the usual way. After the electric street cars were started, the company had a great deal of trouble, and it resorted to various experiments to overcome the trouble. It tried grounding the wires in the middle of the Penobscot river, which, as many of you know, is a very large stream, but while there was a considerable improvement it was quite inadequate, and the company was obliged to go seven miles out of Bangor in order to ground the circuits and be able to work the telegraph lines. The superintendent also told me that in Portland, Me., the company had experienced a great deal of difficulty from the same cause, and at one time it was obliged to disconnect the batteries from the line, and work the telegraph circuit between Portland and New York by the electric current from the trolley wire alone. In answer to one of the questions which Mr. De Camp raised, I can say that I have found it impossible to draw one wire out of a pipe and replace it with a new one satisfactorily. The way in which we are obliged to do that now, if a wire needs to be replaced, is to draw the whole bunch of wires out of the pipe, insert one in place of the damaged one, and then replace the whole lot in the pipe. That can be done without serious injury and leave the wires nearly as good as in the original construction. Considerable difficulty is often found from burs in iron pipes due to carelessness or imperfection in their manufacture, so that it is necessary to inspect all iron pipes quite carefully, if they are to be used for this purpose before they are laid, and also to carefully remove burs at the ends where the sections are screwed together.

Mr. LOCKWOOD: I wish to answer the first question propounded by Mr. De Camp, which was this: What are the merits or demerits of a wood conduit? An experience of 15 years enables me to say that a wood conduit has no merit, and that the wood conduit is one tremendous demerit. It has, it is true, one apparent merit, namely, that of cheapness. I most strenuously object to any consideration of cheapness as a merit in anything. It is true that we frequently find the two terms, cheapness and economy, but I desire to say, that it is never economy to do cheap work.

NEW PATENTS—1893.

23,231. "Improvements in micro-telephones." G. L. ANDERS and W. KOTTGEN. Dated December 4th.

23,239. "Improvements in connection with arc lamps." F. M. LEWIS. Dated December 4th.

23,241. "Improvements in electric storage batteries." W. J. S. BARBER-STARKEY. Dated December 4th.

23,253. "Improvements in electric alarms." J. H. BALLANTYNE. Dated December 4th.

23,283. "Improvements in couplings for connecting together conductors of electricity." L. PENSON. Dated December 4th.

23,303. "Improvements in or relating to accumulators." A. J. BOULT. (Communicated by J. Lecoq, Belgium.) Dated December 4th.

23,304. "Improvements in or relating to arc lamps." A. J. BOULT. (Communicated by J. Lecoq, Belgium.) Dated December 4th.

23,307. "An improvement in conductors and rubbers for electric railways or tramways." F. B. BEHR. Dated December 4th.

23,308. "Improvements in continuous current dynamos, either for generating or for receiving electric currents." M. HUTIN and M. LEBLANC. Dated December 4th.

23,309. "Improvements in continuous current dynamos for either generating or receiving electrical energy." M. HUTIN and M. LEBLANC. Dated December 4th.

23,327. "Improvements in electric lamp fittings." A. J. HOWES. Dated December 5th.

23,331. "Improvements in electrical current regulators and electrical heating apparatus." S. W. CUTTRISS. Dated December 5th.

23,337. "Improvements in electric meters." H. C. L. HOLDEN. Dated December 5th.

23,364. "Improvements in the manufacture or production of electrodes or plates for batteries especially secondary batteries." H. G. SPEARING. Dated December 5th.

23,366. "Improvements in phonographs." H. J. LIORET. Dated December 5th.

23,385. "A combined ammeter and voltmeter." E. W. JEWELL and W. ZIMMERMAN. Dated December 5th.

23,424. "Improvements in incandescent electric lamps." H. GREEN. Dated December 5th. (*Complete.*)

23,436. "Improvements in apparatus for electrolytically producing soda and chlorine." H. H. LAKE. (Communicated by the Union Chemical Company, United States.) Dated December 5th. (*Complete.*)

23,444. "The prevention of humming noise of dynamo-electric machines." F. BAILEY. Dated December 6th.

23,445. "Improvements in incandescent gas lamps." J. ROSS. Dated December 6th.

23,468. "A method of adapting incandescent electric lamps to table, standard, hanging, and other oil lamps." A. B. KENT. Dated December 6th.

23,472. "Improvements in electrical measuring instruments." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. Dated December 6th.

23,477. "Improvements in contacts for electrical signalling." J. ORME. Dated December 6th.

23,478. "Improvements relating to the electrolytic preparation of oxygen and the halogens and to the simultaneous production of electrodes." A. COEHN. Dated December 6th.

23,543. "Improvements in or connected with electric arc lamps." R. J. CANAVAN. Dated December 7th.

23,605. "Improvements in the method of attaching reflectors to electric lamp-holders or sockets." P. G. EBBUTT and J. B. VERITY. Dated December 8th.

23,614. "An improved instrument for controlling the flow of current through electric circuit or circuits." P. O'NEAL. Dated December 8th.

23,633. "An electric motor designed to drive continuously any clockwork or time-keeping mechanism." J. PARKIN. Dated December 8th. (*Complete.*)

23,669. Improvements in electrolytic vessels for primary and secondary batteries or accumulators, and other processes of electrolytic decomposition and electrolytic action, such as for the extraction of metals from their ores, electro-depositions, and the like." P. SCHOOP. Dated December 8th.

23,673. "Improvements in telephones." W. MOSELEY. Dated December 8th.

23,676. "Improvements in and connected with primary batteries, and in safety lamps to be used therewith." H. V. COAD. Dated December 8th.

23,684. "Improvements in connection with the electro-deposition of metals." T. B. BATES and A. E. LEEFE. Dated December 8th.

23,687. "Improvements in telegraphy and in the means employed for perforating tapes used for this purpose." P. B. DELANY. Dated December 8th.

23,688. "Improvements in and relating to electric batteries." L. FORTOUL and C. THEBYC. Dated December 8th.

23,733. "Improvements in electrical means for signalling on railways in a fog and at other times." I. A. TIMMIS and G. N. ABERNETHY. Dated December 9th.

23,744. "Improved method of and appliances for lighting railway trains by electricity." R. J. URQUHART. (Communicated by P. de Y. Y-asmendi, Spain.) Dated December 9th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

14,533. "An apparatus for converting alternating currents of electricity into direct currents." R. N. LUCAS and A. G. NEW. Dated August 11th. Claims:—1. The employment in connection with a revolving commutator of a self-starting and of a synchronising motor, geared to one another by means of the special clutch or device described (through which also electrical contact is made with the self-starting motor), in such a manner that when the revolving commutator is brought to revolve at the required velocity, the self-starting motor is thrown out of gear, and also out of electrical connection with the source from which it is supplied with electricity, and consequently comes to rest, while when the synchronising motor, and with it the revolving commutator, cease, or tend to cease to revolve, the self-starting motor is thrown into gear and into contact with its source of electricity, and the apparatus is in a position to start again and act as before, thus becoming completely automatic in its operation, essentially in the manner and for the purpose described. 2. The electro-magnetic mechanism for maintaining the direction of the converted current constant by rocking the collecting brushes through the requisite angle as described.

14,658. "Improvements relating to electric accumulators or secondary batteries, and to the manufacture of plates or electrodes therefor." A. J. SMITH. Dated August 13th. Claims:—1. The improved method or process of manufacturing a plate or electrode for a secondary battery or accumulator, consisting in repeatedly covering or coating a metal sheet or plate with the metallic oxide, and driving or kneading such oxide into the metal by means of pointed rods or needles, substantially as described. 2. A plate or electrode for a secondary battery or accumulator, in which the particles of oxide are kneaded into the metal by the improved method or process described.

15,197. "Improvements in electrolytic apparatus." H. M. E. ANDREOLI. Dated August 23rd. The principle of the invention is the employment of a conducting porous diaphragm or inner tank, acting as a cathode, in combination and contact with a supplementary cathode, which may be in the form of an outside metallic containing tank or the conducting porous diaphragm, and the supplementary cathode with which it is in combination, and contact may be placed, together with the anode, in a non-conducting tank, and may be disposed horizontally or at any convenient angle at suitable distances from each other. 3 claims.

15,318. "Improvements in electrical transformers." H. H. LEIGH. (Communicated from abroad by G. M. APOLLONJ, of Rome.) Dated August 25th. Claims:—1. The combination of two Paccinotti armatures, the cores of which are reciprocally closed in short magnetic circuit. 2. The combination of a Paccinotti armature with an armature for alternate currents, the cores of which are arranged as described. 3. The combination of a Paccinotti armature with an armature for currents with three or more periods, the cores of which are arranged as described. 4. The construction of this double core by means of a laminated iron ring, pierced with holes, through which two coils are wound in the described way, one primary and the other secondary.

15,437. "An improved method of making electrical contacts between parts of electrical apparatus." W. E. GRAY and W. A. PRICE. Dated August 27th. The inventors interpose between a stream or streams of mercury, and a metallic surface connected with one pole of the battery, a screen carried by a swinging arm, which is operated by a relay, or forms a part therewith. When the screen is withdrawn from under the jet, metallic contact will be established, and when moved to intercept the stream, the current will be broken. 1 claim.

15,689. "Improvements in and connected with relays for electric telegraphs." C. R. J. WILLOT. Dated September 1st. The important features of the polarised relay, according to the invention, are as follows, namely:—1. The peculiar form and arrangement of the soft iron or armatures of the electro-magnet. 2. The mode of suspending and coupling two armatures rigidly connected on the same axis, and the arrangement of the magnetic field in which they move, constituted on the one hand by the polarising magnet of these armatures, and on the other hand by two breeches of soft iron placed at the extremities of the electro-magnet; one of these breeches is subjected to the magnetic action of an artificial magnet, independent of the polarising magnet of the armatures. 7 claims.

16,768. "Improvements in electrically-controlled switching apparatus for telephone or telegraph exchanges." R. PIPPETTE. Dated September 20th. Consists of apparatus by which a person at a point can cause his own wires to be put into connection with the wire or wires of any other person, so that electrical communication can be carried on between them. For this purpose each point is supplied with the ordinary telephonic or telegraphic apparatus, and an apparatus for actuating and controlling the switching apparatus at the central exchange. This apparatus is connected by one or more wires to the central exchange. In the central exchange the wire or wires from the point pass through the switching apparatus special to that point which can be controlled from that point, and by which a person can at will put his own wire or wires into connection with those of any other point, and having finished his communication, cause his own to be disconnected from them, and also at will to cause another point's wires which may be in connection with his own to be disconnected. 8 claims.

17,092. "Improvements in insulating and supporting electric wires intended to act as resistances, applicable as radiators of heat for cooking, warming, and other purposes." R. E. B. CROMPTON and H. J. DOWSING. Dated September 24th. In certain cases, more particularly where electric heating has to be applied to kettles or pans or other apparatus, either of a complicated form or of a highly ornamental character, the inventors make the metallic support to which the electric conductor is enamelled separate from the vessel which is to contain the liquid and attach it to it either by a soldered joint, using solder which will run at a temperature far lower than that at which the more fusible part of the enamel can be damaged, or by a flange joint, using bolts or screws or any of the well known means usually employed to make such water-tight joints. In making electrical cooking apparatus for stewing, baking, or, in fact, for any operation which requires heating to be carried on for a considerable period, and which would thus render the use of electrical energy costly, they combine with the electric heating apparatus carefully arranged methods of coating all surfaces of the apparatus which are not intended to usefully radiate heat with non-conducting substances in a manner well understood, so as to prevent loss of heat. 7 claims.

17,423. "Improvements in apparatus for supplying electricity to electrically propelled vehicles." E. CHABEAULT. Dated September 29th. According to this invention there are arranged at intervals along the track upon which an electrically propelled vehicle is to run, current-supplying devices which, on being placed in electric connection with corresponding devices upon the vehicle, supply current from a main conductor of electricity direct to the motor which drives the vehicle, or to a battery of accumulators which supply current as required to such motor, or to both the motor and accumulators. 4 claims.

17,536. "Improvements in grapnels for submarine cables." E. STALLIBRAS. Relates to the grapnel described in the No. of the REVIEW for September 22nd, 1893.

17,643. "Improvements in electric switches." H. EDMUNDS. Dated October 4th. Consists in arranging, in proximity one to another, two electro-magnets or solenoids, one end of the coil of each magnet being connected by a push button or like contact, with the supply main, whilst the opposite end of each coil is connected to a suitably arranged spring contact piece. Opposite the poles of these magnets or solenoid is a bent double armed lever, which is caused to engage with one or other of the spring contact pieces, according to whether the "on" or the "off" button or contact be depressed. The axis of the double armed lever is electrically connected to the supply main, so that when the lever is attracted by one of the magnets or solenoids, the circuit will be completed through the said lever to the lamps or the like, and when the other magnet or solenoid is excited, the lever will be rocked on its centre, so as to break the circuit through the lamps or the like. 3 claims.

17,855. "Improvements in electrical distribution." T. TOMLINSON. Dated October 6th. Consists in generating the alternating currents by dynamos at a main station at high voltage and conveying these currents to sub-stations conveniently dispersed about the district to be lighted. At each sub-station is provided a transformer which gives a current at double the voltage required by the consumers. At this double voltage the current is conveyed by a pair of mains to a point to which also the low pressure or house mains are brought. 2 claims.

17,922. "Improvements in secondary batteries." F. KING and E. CLARK. Dated October 7th. Consists of grids, retainers, or supports, having perforations of any suitable form, from the inner walls of each of which perforations are pins or projections, inclined at an angle to the surface of the plate, and extending towards the centre of the perforation, so as to form claws to engage and retain in position the active material which is placed in the perforations of the grid or support. 1 claim.

18,037. "Improvements in electric welding apparatus." W. C. MOUNTAIN. Dated October 10th. Consists in causing the electric arc whereby the weld is to be effected to distribute the intensity of its heat over an increased area by means of an U-shaped or other suitably formed receptacle adapted to contain water after the manner of a water jacket and fitted with means for the circulation thereof therethrough. This water jacket is designed to form an outer casing or jacket to an inner body or brick of carbon firebrick ganister or other suitable refractory material. 2 claims.

18,166. "Improvements in microphones." H. H. LAKE. (Communicated from abroad by E. Noriega, of Mexico.) Dated October 11th. Consists in a diaphragm of wood or analogous material, with the edges bound with elastic rubber binding, perforated carbon blocks secured to the diaphragm, carbon cylinders inserted in the perforations of the blocks, a pressure spring for holding the cylinders against the sides of the apertures in the blocks, and a body of fibrous absorbent material interposed between the spring and the carbon cylinders. 1 claim.

18,359. "Improvements in electric regulators." A. L. DAVIS. Dated October 13th. Relates to apparatus which automatically effect regulation of electric currents by introducing more or less resistance or a greater or less number of battery cells into a circuit, or which automatically regulate the distance of the carbons of an electric arc lamp. 2 claims.

18,878. "Improvements in the connections of the parts of earthenware articles employed in connection with electrical switches, cut-outs, ceiling roses, and the like." T. TAYLOR and W. TUNNICLIFF. Dated October 21st. By this invention, the base and the cover of earthenware articles are coupled together by inside and outside metallic intervening attachments in the form of rings or annuluses screwed inside and outside respectively, and with one of the said attachments fitted circumferentially around a neck of the base part, and the other fitted circumferentially within the mouth of the cover part, so that by screwing the attachments together, a coupling of the two part earthenware articles is thereby performed. 2 claims.